no action req'd

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: August 17, 1976

Project Title: Poultry Industry Research

Project No: A-1879

Project Director: Jr. James F. Lowry

Sponsor: Georgia Department of Agriculture, Atlanta, GA

Agreement Period: From August 1, 1976 Until July 31, 1977

Type Agreement: Standard Industrial Agreement dated 7/13/76

Amount: $182,000

Reports Required: Monthly Progress Letters; Annual (Final) Technical Report

Sponsor Contact Person (s):

Technical Matters

Mr. Hubert F. Jordan, Jr.
Fiscal Resources Officer
Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Contractual Matters
(thru OCA)

NOTE: Follow-on to A-1771

Defense Priority Rating: None

Assigned to: Productivity/Technology Applications (~~School~~/Laboratory)

COPIES TO:

- Project Director
- Division Chief (EES)
- School/Laboratory Director
- Dean/Director—EES
- Accounting Office
- Procurement Office
- Security Coordinator (OCA)
- Reports Coordinator (OCA)
- Library, Technical Reports Section
- Office of Computing Services
- Director, Physical Plant
- EES Information Office
- Project File (OCA)
- Project Code (GTRI)
- Other

CA-3 (3/76)

GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

40 action OCA

Date: January 9, 1978

Project Title: Poultry Industry Research

Project No: A-1879

Project Director: J. F. Lowry

Sponsor: Ga. Depat. of Agriculture

Effective Termination Date: 7/31/77

Clearance of Accounting Charges: 7/31/77

Grant/Contract Closeout Actions Remaining:

X Final Invoice ~~XXXXXXXXXXXXXXXXX~~
_ Final Fiscal Report
_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other ____________________

...Development Laboratory (School/Laboratory)

Library, Technical Reports Section
Office of Computing Services
Director, Physical Plant
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other ____________________

CA-4 (3/76)

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

September 10, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for period 15 August 1976 through 31 August 1976

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Activities at Cumming involved the repair and maintenance of the agitator, gas meter, and vacuum pump. In addition, modifications were required of the manure loading system as excessive losses of raw manure at this time of year were being realized, with a consequent increase in the level of foul odor.

A new electrical control system was designed and will be used for a more simplistic operation of the various modes of operation of the digestor.

The digestor is being geared up for the next full-scale run in the well-stirred mode of operation.

In our laboratory program, the five-gallon batch reactor experiments have been terminated and data on pH, viscosity, gas evolution, and quality is being interpreted while again setting up for a new series of experiments. In addition, a plug-flow model reactor made of Plexiglas has been built and is being tested for leaks. This prototype reactor is expected to provide invaluable back-up data for the operation of the Cumming digestor.

Project 002

On August 2, 1976, an energy conservation seminar was held for members of the Georgia poultry industry. The program included presentations by EES project personnel and engineers working in the Georgia poultry industry. Attendees included management personnel from eight of the large integrated poultry operations in the state.

Work was initiated on demonstration projects and engineering analysis of three areas of energy consumption in broiler growout operations:

1) Lighting - Project personnel visited the demonstration project initiated in February in which incandescent lighting was replaced with flourescent lighting. The results to date are excellent, and, where feasible, installation of flourescent lighting will reduce energy requirements for lighting by 60% or more. Savings are also evident in bulb replacement cost. Return on investment indicates a payback of less than one year.

2) Ventilation - A monitoring system was installed in a growout house for determining the utilization rate of the fans in the structure's ventilation system. This monitoring program will be installed for an annual cycle in order to provide a basis for evaluation of fans with respect to first cost and operating cost.

3) Heating - An evaluation of the efficiency of gas utilization in brooders currently on the market and in use has been initiated. Relative efficiencies will be determined from manufacturer's specifications and past research performed on brooder efficiency. This evaluation will ultimately provide the basis for an economic analysis of brooders currently available and alternative means of supplying heat.

The demonstration programs initiated during last year's energy conservation program are being evaluated as operating data becomes available.

Project 003

This period plans were made for the evaluation of the solar/broiler growout house in Cumming, Georgia. The desirability and feasability of adding an automatic control system is under study as are possible design modifications.

Project 004

Efforts on this project to date included identification of the packaging process and its associated problem. Specifically this includes:

1) Researching present methods of packing birds

2) Identifying those methods and problems pertaining specifically to Georgia industry, and in particular plants within Georgia

3) Establishing a priority rating on those problems identified above (i.e., the problems of packing the birds when taken from the chiller is more urgent than the packing of cut chickens)

4) Evaluation of various technological methods to be applied to the problem of the packing process.

This effort will continue into the research of machinery which can be modified to meet the requirements of automated packing.

Respectfully submitted,

James F. Lowry
Program Manager

JKL:sc

R. L. Yobs
Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

October 11, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for period 1 September 1976 through 30 September 1976

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Pilot plant activities at Cumming were adversely affected time-wise because of the unavailability of the loading truck. That situation worsened when we were informed that (a) modifications to the truck were necessary in order to ensure against complaints from neighbors due to odors, and (b) that the truck was in such a state of deterioration that our proposed modifications could not be made, at least via welding techniques. This modification is now underway.

In the laboratory the Plexiglas plug-flow model has been installed and checked and is ready for loading. In addition we are on schedule with our next series of five batch experiments, four of which are being run mesophilically and hyperbarically at different concentrations and one of which is being run thermophilically. Initial results indicate excellent yields will be obtained at relatively rapid rates.

Mr. Poulin has written a technical paper on the subject of large-scale anaerobic digestion which will be presented at the First Congress of International Technology to be held in October in Pittsburgh.

We have initiated communication and exchange of information with groups in North Carolina and at Tennessee State, as well as reactivating liaison with Hardin Simmons University

Rheological studies which were commenced under project A-1771-001 were completed during this past month. Results indicate that both the "above exhaust" and "bottom loading" modes of operation for plug-flow reactors are feasible.

Project 002

During September, further work was done in energy conservation in broiler growout and layer operations. The monitoring program to determine ventilating fan utilization rates is providing continuous data which is being reduced regularly. Data is also being compiled on brooder efficiency. Jim Lowry and Richard Combes attended the first regular meeting of the newly-formed Broiler Production Council and arranged to present a seminar on Energy Conservation in Broiler Production in December of this year. In addition a pamphlet addressing means for reducing energy in broiler growout and layer operations has been drafted and will be printed and disseminated by the Georgia Poultry Federation.

Energy conservation measures are being implemented at the Gold Kist, Inc. broiler processing plant in Ellijay, Ga. and engineering assistance is being offered by project personnel.

Project 003

Instrumentation was installed in the solar/broiler house to measure the effectiveness of the solar system. A flock of chicks arrived on September 27, 1976 and in spite of several overcast conditions the solar system provided sufficient heat until the evening of September 29th. Brooders were in operation during the entire period on the two non-solar houses.

One of the panels, which had been damaged by a dog, was repaired. The glazing was replaced with SUN-CLEAR treated M-602 plastic. This provides an opportunity to test the effectiveness of SUN-CLEAR as a moisture inhibitor.

A second problem was discovered. Six of the outlet pipes were blocked by an accumulation of dirt. The cause of the accumulation could not be discovered but probably occured during cleanout. This problem is in the process of being repaired and data are continually being acquired.

Project 004

Activities this period involved the initial design of equipment to remove the broiler from the drip line and place it into a shipping carton. This included the development of a microprocessor to determine which birds go into which boxes. This will give the uniformity of weight and desired weight in each box.

Respectfully submitted,

James F. Lowry
Program Manager

R. L. Yobs, Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

November 5, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for period 1 October 1976 through 31 October 1976

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Modification of the manure loading truck and receiving, holding tank has been completed and is in working order. During our restart phase to achieve a well-stirred reactor it became necessary to completely purge the digester of the original population. This was done and internal repairs have been made in preparation for reloading.

During the reloading process several problems have occurred and been repaired including:

(a) Fixing the heating element in the digester,

(b) adding support to butress the foundation of the instrument house,

(c) restoring the agitator to operational condition and

(d) repositioning digester level controls.

The major problem encountered to date is that six of the outlet air pipes are clogged with dirt. These pipes will be cleaned the next time the house is empty.

Project 004

An economic study of the poultry packaging process has been conducted and will continue. Listed below are the more detailed assumptions of the economic analysis of the systems.

(a) The interest rate is 12 percent,

(b) the system's cost was calculated for capital payback, in both three and five years,

(c) system operation is based on a 250 work day year, and

(d) maintenance is conducted on weekends.

The results of this study will indicate the maximum cost of each unit in the automated packaging unit.

The five best palletizing machines to be used in the APPS (Automated Poultry Packaging System) have been chosen.

A search for the best commercially available equipment to be used in the APPS has been conducted and will continue.

Future goals are:

1. Complete the economic analysis.

2. Choose the best commercial equipment for each function in the APPS.

3. Prepare a preliminary optimum layout for the APPS.

Respectfully submitted,

James F. Lowry
Program Manager

JFL:sc

R. L. Yobs
Laboratory Director

Another problem of concern is that the layer house owner, Bobby Smith, has begun to investigate the use of insecticides "Vapona" and "Rapon" as agents for killing the maggots in the poultry waste. We do not know, but are concerned whether the whole biochemical nature of the reaction might be altered by their presence. If effective on maggots, the insecticide treatment will be adopted as a standard procedure. We will initiate an information search on the insecticides to determine their effect on the digester operation.

At this time we are experiencing severe problems with loading the digester. Unlike our original experience, clogging of the transfer pump is not the source of the problem (the new pump is working extremely well), but is due to grit (including what appears to be chips of ceramic material) accumulation and blockage along the pipes and at joints between the mixer and digester. Once again loading becomes tedious as the pipes must be cleaned periodically. We believe that it will take an additional two weeks to complete loading (presently, there are one and one-half loadings from the mix tank - obviously, with no agitation as the pipes are being cleaned.)

Our laboratory experiments are on schedule and are progressing well. We have the assistance of an undergraduate chemistry major to expedite lab results.

Our EPA proposal should be completed within the next two weeks.

Project 002

A literature search was continued to determine the availability of current data on gas brooder and ventilating fan energy efficiency. The survey has included conversations with poultry researchers, equipment manufacturers and other university researchers. Visits were made to two North Georgia egg production and processing facilities and interviews were held with the facility management concerning energy conservation in the egg industry.

Project personnel have contacted management personnel at North Georgia Rendering Co. who have expressed a desire to work with EES engineers on an energy conservation demonstration program. An energy survey of the facility is planned for November.

Richard Combes, Project Director, traveled to Asheville, North Carolina and presented a research report on "Energy in the Poultry Industry" to the Dixie Poultry Convention on October 4, 1976.

Project 003

This month data collection began on the solar/broiler growout house. In the four-week period beginning September 19 with the arrival of baby chicks the solar house used 60% less gas than the control houses. This is despite the fact that the solar house, because of its orientation and construction, normally uses more gas than the control houses.

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

December 6, 1976

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attention: Mr. Hubert F. Jordan

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for period 1 November 1976 through 30 November 1976

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

The loading of the Cumming digester was completed during November. Blockages due to grit accumulation continue to create problems. These must be cleaned out each day.

Within two weeks of loading, a methane level of 60% was achieved and this rather surprising result suggests that bioconversion was occurring at a rapid rate, in effect reducing the induction period substantially. However, due to corrosion of the gas meter, we were not able to measure the actual gas production rate. Consequently, one must exercise caution in interpreting the high methane levels. The only obvious major difference between this loading and the original loading was that we did not "seed" with cow manure this time but allowed the poultry manure to react itself.

When a constant methane level was achieved, we began circulation and inexplicably, gas production ceased. It has since restarted and a level of 65% methane at a gas production rate of 25 cu.ft./hr. is being recorded.

Mr. Smith has ceased use of insecticides.

Laboratory experiments with the plug flow reactor model have commenced. Data is being generated on sedimentation rates and the nature of separation which will greatly assist in further process studies. The gas production rate and composition is being monitored on this experiment plus five concurrent batch experiments.

Mr. Thomas Irvin provided us with a letter approving the use of GDA funds to effect matching funds from federal agencies. A grant of $100,000 is being negotiated from EPA.

Mr. Poulin has authored a paper which Dr. O'Neil has edited. It describes the design of the Cumming digester from a chemical reactor design standpoint. It will be published. A verbal presentation will be made to ERDA (R. Warde) on 21 December by Poulin with the intent of influencing federal funding for future work on the program.

Project 002

Energy conservation efforts in broiler growout operations continued with the managers of two major poultry growout operations, Strain (Cagle's) and Fielddale, requesting engineering assistance in installing a demonstration program for fluorescent lighting systems. Additional work in the growout area included surveying existing gas brooder operations to determine relative efficiency of different brooder types. The monitoring program to measure utilization factors for ventilating fans in broiler houses is continuing.

Energy conservation in rendering operations is being addressed with surveys of the North Georgia Rendering Co. facilities in Cumming, Georgia, and the Gold Kist Rendering Plant in Ball Ground, Georgia. Consultations with Gold Kist engineers have produced some attractive ideas in waste heat recovery in rendering plants. Especially attractive is the use of recovered heat from rendering operations for use in processing plants at those facilities which have both operations on the same site.

Project 003

Data collection during operation of the solar heated broiler growout house continued through this period. Data have been collected for one complete flock of chickens. Despite rather poor climatic conditions for solar collection the results were quite encouraging. Natural gas in the solar house was reduced by 42 percent or 24,200 cubic feet over that of the average of two control houses. Data collection will continue when the next flock is installed in the broiler house. During the intermediate period the plugged heating ducts will be opened.

Project 004

Equipment selection for the APPS (Automated Poultry Packaging System) was the primary objective this month. We continue to receive product information from different companies. This information and information gathered from plant visits have enabled us to make equipment selections for palletizers, box icers, check weighers, and box weighing scales. At the present time the information search has not ended for marking and lab applying systems. A proposal for the construction of a box closing machine will be submitted by a manufacturer that makes similar machines.

A plant schematic of the Ellijay Gold Kist plant has been drawn that includes existing equipment and alternative equipment made by the other major manufacturers of poultry equipment.

Palletizing packed boxes presents some interesting problems with product flow. Information from materials handling equipment manufacturers has not been received yet, therefore decisions have not been made in this area.

Future goals:

1. Complete equipment selection.
2. APPS plant layout.

Respectfully submitted,

James F. Lowry
Program Manager

JFL:sc

R. L. Yobs
Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

January 5, 1977

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Attn: Mr. Hubert F. Jordan

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for period 1 December 1976 through 31 December 1976

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Because of the inexplicable stoppage of gas production with circulation during the last month the decision was made to empty the digester and replumb it during the Christmas early January period. This modification will allow for bottom loading/top removal and will answer the question as to the viability of laboratory data which indicates this to be a much more efficient mode of operation. It is anticipated this modification will be complete by January 15, 1977. At this time the digester will be reloaded, incubated and operated in a steady-state loading/unloading condition to determine efficiency of operation.

Data are continuing to be gathered in the laboratory from the plug flow reactor model as to sedimentation rates and the nature of separation. Also gas production and composition is continuing to be monitored on five concurrent batch experiments.

Project 002

Lighting systems were designed for the environmental type broiler houses built by Fieldale, Inc. A test program to determine the effectiveness of fluorescent lighting in these houses is being initiated. In addition, a new type of infrared gas heater, which exhausts all products of combustion outside the broiler house and requires no pilot light is being examined, in anticipation of a demonstration program. This type heater has a potential gas or propane savings of 30-50% over conventional gas brookers. Elapsed time recorders have been procured and it is planned to install these recorders on the ventilating fans in an environmental broiler house to compare fan utilization data with the data being collected for a fan ventilated side-curtain house. This comparative data will prove useful in evaluating energy costs differences between the two types of broiler houses.

Project 003

The solar system has been shut off for this current flock of chickens. This will provide an opportunity to obtain an exact comparison of the heating requirements of the solar house and the two non-solar control houses.

During this period wire mesh will be installed over the openings of the concrete pipes that connect the collector to the broiler house. This will prevent the entrance of rodents into the pipes which created a partial blockage of hot air flow during initial tests.

Project 004

The two areas of poultry packaging focused upon this month were the labeling of the boxes containing the finished product and the palletizing of these boxes.

In regard to the type of label used to identify the ten different boxes of chickens in the average plant (five weight classifications each with or without giblets), we found that the present label used is the optimum label. These preprinted labels will be applied to the box and the only information supplied to the label at this time will be the date. The labels will be either pneumatically stapled or glued to the boxes at the quality control station in front of the scale where the weight of the boxes are being checked.

As stated earlier, work was also done on the palletizing substation. We found that since there are ten classifications of boxes, ten palletizers could be used. This arrangement was found not to be feasible since the two people saved by it are more economical than the ten palletizers. We then designed another system which required only one palletizer. This system uses a storage sub-system which stores similar boxes until a full pallet load is ready to be palletized. The storage sub-system would then release these boxes to the palletizer and a full pallet load of similar boxes would be palletized. We found that this system's cost is approximately half of the one using ten palletizers. We are now in the process of working on the feasibility study associated with this system. We believe that it will also be nonfeasible in which case we will recommend that the present manual method of palletizing be used.

JFL:sc

R. L. Yobs
Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION

GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

February 9, 1977

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for Period 1 January 1977 through 31 January 1977.

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Work on the mechanical design modification of the Cumming digestor has been completed despite the unseasonably cold weather. Visits with Dynatech and ERDA confirm that the Cumming design is probably the most versatile large-scale system in operation in the U.S. and is expected to improve significantly the probability for successful economic operation. In addition, the new design enhances chances for attracting matching funds from federal agencies. The single most troublesome aspect of efficient operation of digestors nationwide, has been the problem of grit blockage. It appears that the Georgia digestor is the first operation to overcome this problem.

Current activity focuses on the installation of a new electrical control system which will greatly simplify operation and maintenance. The installation should be completed by the end of February, when full-scale testing will commence.

Data on protein content, amino acid profile, and NPK characterization is being gathered on the converted, dry effluent. An updated economic analysis of the anaerobic digestor process is being performed, based on current values of biogas and biomass. The increase in natural gas costs obviously enhances the economic projection.

Project 002

Work continued in implementing energy conservation in the broiler production sector by providing flourescent light fixtures for a broiler house managed by Strain Poultry, Acworth, Georgia. The flourescent fixtures, and electric cost savings will be calculated through comparison of electric costs of another broiler house at the same site, which continues to use incandescent lighting. A flourescent lighting system was also designed for a number of breeder houses located in Gainesville, Georgia. A study has been initiated to determine the feasibility of providing a poultry house heating system which wll use coal or wood as a fuel.

Work in poultry processing plants involved evaluation of a heat recovery system which recovers heat from the ammonia refrigeration cycle. The system was proposed to Gold Kist, Inc., and is being considered for installation.

A survey was made of the egg processing facility at C & C Farms, Claxton, Georgia, and a report with recommendations for energy savings is being prepared. In addition, arrangements were made to visit Crystal Farms in February to discuss the feasibility of a solar water heating system.

Project 003

The solar system was shut off during this period in order to determine the exact relationship between the heating requirements of the broiler house in which the solar system is installed and the control houses. It was found that the house with the solar system normally requires 11% more natural gas to heat it than the control houses. Making this adjustment to the figures from our previous test period, it is found that the solar system provided 47% of the heating requirements of the broiler house, rather than the previously estimated 40%. Additional solar data will be acquired during the next flock of broilers.

Project 004

After determining last month that the labels should be either pneumatically stapled or glued to the box at the quality control station, we realize that the time required to perform this function should be minimized. We are searching for a commercial machine and/or designing a machine that will perform this function as fast as possible. We are looking for a stapler that, upon command, will shoot four staples, one in each corner of the label. We are also considering mounting this stapler on a rotating arm, such that the operator could bring the stapler to the desired spot as easily as possible. The only problem with using staples is the possibility of contamination. This problem will be considered.

The other alternative is gluing the label to the box. The problem with gluing is that the oeprator could get glue on his hands. This is not good, since the operator will be handling chickens. Details on both gluing and stapling operations still need to be completed.

We checked the prototype of the machine that will pack the birds from the drip line into the boxes. We are now combining this machine with our system. We did an economic study to find how much capital could be invested in the machine to make it feasible. A machine that puts the labels into the boxes was found and more information is being sent. We will try to combine this machine with the packing machine. Therefore, the birds will be packed into the box and a label will immediately be placed on top of the birds. The full box with the label will be conveyed to the icing station.

Future Steps to Complete the Project

1). Layout drawing of an automated packaging operation indicating dimensions; List of the commercial equipment that we choose;and, a drawing of equipment that we designed.

2). Combine the economic studies of each subsystem into a comparison of the economic advantages and disadvantages of the present system versus the new system.

Respectfully submitted ,

James F. Lowry
Program Manager

R.L. Yobs
Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

March 7, 1977

Georgia Dept. of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for Period 1 February 1977 through 28 February 1977.

Attn: Mr. Hubert Jordan

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

The major activity has centered on the completion of the rewiring of the pilot plant at Cumming in order to provide multi-modal operation. A fail-safe system has been devised to by-pass malfunctioning equipment and to avoid shut-down of operation. A control cabinet has been designed and built. The rewiring is nearly complete. We are preparing to load the digester with water to test out the new system in preparation for resumption of large-scale testing.

Sludges were isolated from the laboratory experiments conducted at 10% and 20% v/v. The following analyses were performed:

	10%	20%	Typical Chicken Feed
Moisture, %	3.1	15.0	
N, %	1.85	1.59	
N (As Protein), %	11.56	9.44	15
*Digestible Protein (Pepsin), %	2.51	1.00	3 0
P_2O_5, %	13.81	8.86	3.0
K_2O, %	0.77	0.38	0.6
Crude Fiber, %	15.38	13.24	5

* The Pepsin Digestible test indicates a low value as a non-ruminant feed. These results represent a particular method of sludge processing. Other methods have yet to be tested.

Project 002

Work in the poultry farming sector included installation of fluorescent lights in a breeder house in Gainesville, Georgia. This installation will be the test house to determine the feasibility of fluorescent lights in ten breeder houses at the same site. The estimated savings in electric cost for all ten houses is $650/month. Fluorescent lights installed over a year ago under this program in a broiler house near Athens, Georgia have been very successful. The investment in the lights was paid out in less than a year in reduced energy costs and no bulbs have yet needed replacement.

A visit was made to the Crystal Farms egg processing plant and an energy survey was conducted. Based on the survey, recommendations were made to recover waste heat from an incinerator to provide all the hot water requirements of the egg washing operation. A similar report was prepared for the egg processing facility at C & C Farms in Claxton, Georgia.

A visit was made to the Cagle's Inc. poultry processing plant in Camilla, Georgia and a talk on energy conservation was presented to the plant management and supervisors.

A visit was made to the Wayne Poultry Plant in Pendergrass, Georgia to explore the feasibility of using waste heat from the plant's rendering operations to heat makeup water to the scalder in the processing plant. Energy conservation in the rendering operations was discussed and a report is being prepared.

Project 003

This month we obtained eight different types of tape to test for their weatherability and suitability for the solar collector application.

We should be able to report on the preliminary results of the tests next month.

The blocked in air pipes were cleaned out. It was found that house litter was the blocking agent. The litter probably entered the pipes when the house was being cleaned, if the covers were left off the pipes during this period.

A new flock is in the house now and data are being collected on the system performance.

Project 004

Investigation into the optimum whole bird packaging systems have continued. Information has been received concerning stapling and gluing labels to the boxes. It appears that gluing the label to the box will be a potential contaminate and unacceptable for proper quality control. Therefore, the label should be stapled to the box as done by Gold Kist in Ellijay. Also, pertaining to dispensing a label into the box immediately after the chickens are automatically packed, detailed information has not been received concerning the machine which will perform this task. However, the machine has been viewed and it performed acceptably. Further economic analysis of the total system will continue during the next period.

Respectfully Submitted,

J.F. Lowry
Program Manager

R.L. Yobs
Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

April 14, 1977

Georgia Dept. of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for Period 1 March 1977 through 31 March 1977.

Attention: Mr. Hubert Jordan

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Activities this month have centered on:

(a) An economic study to re-evaluate the potential for anaerobic digestion on a poultry farm using a 40,000 hen operation as model. Our projections for the simplest mode of operation (continuously stirred digester) indicates that the process will be commercially practical, assuming we achieve the gas production rates obtained in the laboratory. Using a "sensitivity" analysis-type approach, we predict substantially improve economics, particularly if another mode of operation (plug-flow) can be achieved. The results of these analyses were predicted on a value of $2.25/MCF for natural gas. Substantially brighter forecasts would result if propane were used as reference. It appears that the isolated effluent (sludge solids + "biomass", i.e., single cell protein) will provide the greatest value, although surplus biogas (not used for process or farm operation) will still be substantial.

(b) Sludge treatment and analysis. We have been developing a small flume for fractionation and separation of residual, processed sludge. This is based on particle separation by variable-velocity water pumping and filtration. By simple filtration we have isolated a fraction of predominantly rough fiber in the effluent. It was that fraction which was analyzed for fertilizer and food values in the last period. We are working towards isolating the more valuable non-fibrous, fine particle portion of the effluent at present. Further analyses of these fractions are then planned.

(c) The wiring was continued and the circuitry tested to ensure predicted operation of the full scale digester. The "brain" or control center worked perfectly and we now have a virtually fail-safe control and signalling facility for monitoring blockages and locating them as they developed. Full-scale testing is planned to resume this month.

Project 002

Further evaluation of lighting and ventilation systems in broiler and breeder houses was performed. In addition, manufacturers of wood burning stoves have been contacted regarding possible alternate brooding systems for broiler growout, and currently marketed wood burning heaters are being evaluated.

Visits were made to broiler processing facilities including Gold Kist plants in Carrollton and Athens, Mar Jac, Inc., Central Soya of Athens, and J. D. Jewell, Inc. to discuss progress in energy conservation at these processing facilities. Energy consumption data for all sectors of the poultry industry was first compiled in 1975. These data will be updated with energy audit forms now being distributed to the industry. The energy data will be evaluated using the Georgia Tech computer facilities and the results will be made available to the industry members.

Project 003

After testing eight types of tape we have determined that a 3-inch wide foil tape is the most suitable for application to the solar collector. It adheres well and does not degrade when exposed to ultraviolet radiation.

A presentation explaining the design, construction and operation of the solar heated grow-out house was given in Gainesville at a Broiler Seminar sponsored by the University of Georgia Cooperative Extension Service. Dr. Rand from the Extension Service used data supplied by us to calculate the pay-back period of the system which he found to be about 5 years.

Project 004

Progress to date consists of refinements to the conceptual automatic poultry packaging system (APPS). Additional information received from vendors indicates that the palletizing system would simply be too costly for processing plant operation. A preliminary economic analysis of the palletizing system indicates a payout period far beyond that considered acceptable by the industry.

The heart of the APPS, the whole bird packaging machine, was revisited and more detailed information concerning the operation and maintenance characteristics were obtained. There are three units operating in one plant now and five others are in the fabrication stage. The manufacturer has expressed an interest in installing at least one of the newer units in a Georgia processing plant. He feels that the majority of the developmental problems have been solved and has confidence in the design.

The performance of the machine is very sensitive to the plant layout. The design of the unit is such that an automatic box feeder and remover could be built into the machine, reducing human involvement to a supervisory function. The downstream activities of icing, weighing, putting the boxtops on, etc. are so simple that to replace them with machinery would introduce additional complications. One person would be capable of monitoring and handling the output of several packaging machines.

Some thought has been given to methods of increasing overall plant yield by better control of the various mechanical and human activities all along the processing line. Extensive usage of microprocessor control systems and early segregation of birds according to size have been considered as a means of optimizing the performance of such operations as eviscerating and lung removal. Consideration has also been given to the frontend operations of unloading the trucks, coops and hanging the live birds on the shackles. These ideas may best be developed in the upcoming years program. Future work will center about the development of an optimum layout for the packaging machine and the integration of automatic box feeding and removal from the unit. More detailed economic data will be developed for the packer and the other backend systems.

Respectfully submitted,

James F. Lowry
Program Manager

R. L. Yobs
Laboratory Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

May 5, 1977

Georgia Dept. of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for Period 1 April 1977 through 30 April 1977

Attention: Mr. Hubert Jordan

Dear Mr. Jordan:

This summarized activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

The digester was recommissioned in its new multi-modal design configuration. A complete overhaul of the pilot plant plumbing and associated electrical work was completed successfully. We estimate a savings of some $23,000 by performance of the redesign by EES personnel, as opposed to outside subcontractors.

Evaluation of chemical analyses on sludge from laboratory digesters indicates that the sludge could be used as a ruminant feed supplement. We are considering the efficiency of sludge isolation processes, e. g., rotary vacuum filtration vs. filter press filtration.

A revised economic forecast analysis of the process suggests a much shorter payback period will result than initially predicted and that the process will prove to be successful. A verbal report was given to the Georgia Poultry Federation Research Committee.

We are recommencing large-scale runs, operating the digester firstly as a well-stirred reactor (WSTR).

Project 002

In the area of broiler growout operations, new recording devices were installed at the Wilson Foods growout house in which the ventilation system is being monitored. Electric energy consumption data for flourescent lighting systems versus incandescent lighting systems in broiler and breeder houses is being compiled. A company which manufactures wood-burning heating systems has been located in Little Rock, Arkansas. The Lyndale Manufacturing Co. has installed their heating systems in broiler houses in Arkansas, using a forced air wood-burning system. This system is being analyzed for application in Georgia.

Energy audit forms, which detail the energy consumption in broiler processing plants have been sent to seventeen of the largest processing facilities in Georgia. These data will be compared to data collected from broiler processing plants in 1975 and industry trends in energy consumption will be evaluated, with results made available to the industry. Visits to discuss energy conservation projects were made during April to Mar-Jac, Inc., J. D. Jewell, Marell Poultry Co., Gold Kist (Carrolton), and Wilson Foods.

Project 003

During this period the solar system provided 33% of the energy required by the broiler house in spite of the fact that tape was not installed between collector panels and a great deal of heat was lost to the atmosphere. The tape is now in the process of being replaced.

A meeting was held with Strain Poultry Farms at which they agreed to help finance another solar broiler house. We will pick out the facility to be retrofitted and begin drawing up plans in the next few weeks.

Project 004

Follow-up conversations with Paul Altenpohl indicate that he is still very much interested in locating one of his early production models of the automatic packaging device in a Georgia plant. He indicated that we would be able to begin concrete negotiations and site selection around the 16th of May. Based on my visits to a number of poultry processing plants throughout the state, I informed him that the Marrell Poultry Company, based on their attitude towards new ideas and their obvious mechanical abilities to make things work, would be my choice of the prime location. Altenpohl said he was fimiliar with the Marrell operation but would not commit himself.

Other activity during the month centered about setting up a mechanization survey similar to the energy survey that R. Combes mailed out recently. The survey has three objectives:

1. Determine the overall level of mechanization in the processing plants throughout the state

2. Identify problem areas that each processor is experiencing

3. Solicit ideas from the processors themselves as to what they feel are the biggest problems in mechanization.

Some preliminary work has been started with regard to next year's project. I've been outlining what I think the objectives of a process control system should be and what sort of pitfalls can be expected in trying to implement such a system.

We have been informed the proposal to conduct energy conservation studies in a poultry processing plant has been accepted by the Energy Research and Development Administration. This work will begin June 1, 1977, and will study energy use in the Gold Kist (Ellijay) plant. This total project will last for 18 months with a total of $220,000 federal dollars coming into the state to help our industry.

We at the EES are grateful to you and the Commissioner for your efforts in our work with the poultry industry. I think you can be justifiably proud for without your support we could not have acquired this additional contract.

Sincerely yours,

JAMES F. LOWRY
Program Manager

R. L. YOBS
Lab Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332

June 15, 1977

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for Period 1 May 1977 through 31 May 1977

Attention: Mr. Hubert Jordan

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

A paper was presented at the European Seminar for Biological Solar Energy Conversion Systems in Grenoble which described our general work to date. As a result, liaison has been established with researchers in Vienna, Scotland, and France as well as at Kansas State University during this month for purposes of technical exchange.

Our laboratory effort has been relocated to the Emerson Building. Gas chromatographic analysis, i.e., data reduction, has been completed. We are setting up for additional testing of products from Cumming, e.g., volatile solids, N, P, K, etc., and have received offers of cooperation from Department of Civil Engineering for additional testing.

Work at Cumming was interrupted by our change of laboratories but we have nearly finalized the necessary preparatory commissioning of the four principal modes of operation and expect full-scale loading to commence in early June.

Project 022

The results of the energy consumption survey which was sent out in April have been received and are being evaluated for broiler processing facilities. Preliminary evaluation of the data indicates, that while energy consumption rates are lower, energy costs are higher. In one processing facility, energy use per bird dropped 20% from 1974 to 1976, but the energy cost per bird processed rose by 14% during the same time period, indicating a net increase in the energy cost of 42.5%. Final comparative results for the processing energy audit are expected in June, with the results to be disseminated to the industry members. Audit forms for poultry feed mills, hatcheries and rendering plants will be sent out in June.

Visits were made to Douglas Foods, Inc. and Swift & Co. in Douglas, Georgia. The operations were surveyed and energy conservation in processing plants and rendering facilities was discussed. A visit was also made to the Cagles, Inc. processing plant in Macon.

Monitoring of the demonstration projects in broiler house lighting and ventilation is continuing.

Project 003

The start-up of the final design and construction of the extended roof solar collector system has been delayed because Cagle's has informed us that they do not have the financial resources to support the project at this time. Mr. George Deadwyler, Chairman of the Resource Committee of the Georgia Poultry Federation is assisting us in locating a company to help sponsor the project.

The solar system has been shut-off because of the warm weather. The plastic glazing is still holding up well, however, the tape has not yet been replaced on the collector. This will be done during the next period.

Project 004

Work for the month of May centered on determining the poultry processing plant best suited for the trial application of the whole bird packaging machine. When questioned about their interest, the processing plants were uniformly enthusiastic about being considered.

Evaluation of the several plants that were considered has reduced the list to the Mar-Jac plant in Gainesville and the Marrell plant in Murrayville. Both the management attitude and staff capabilities make these plants excellent candidates.

The W. F. Altenpohl Company has finally completed the first five production machines which include an automatic box loader/rejecter feature. Negotiations have produced a desire on the part of the Altenpohl Company to install a complete system of several machines in one of the Georgia plants as opposed to only one unit as was originally intended. This will allow the true effectiveness of the system to be evaluated more realistically. It is anticipated that the negotiations will be completed in the first part of June and the installation will begin shortly thereafter.

Sincerely,

James F. Lowry
Program Manager

R. L. Yobs
Lab Director

A-1879

ENGINEERING EXPERIMENT STATION
GEORGIA INSTITUTE OF TECHNOLOGY • ATLANTA, GEORGIA 30332
GEORGIA PRODUCTIVITY CENTER

July 1, 1977

Georgia Department of Agriculture
Agriculture Building
Capitol Square
Atlanta, Georgia 30334

Subject: Monthly Progress Summary Letter for EES/GIT Research Project A-1879 for Period 1 June 1977 through 30 June 1977

Attention: Mr. Hubert Jordan

Dear Mr. Jordan:

This summarizes activities on Research Project A-1879 with the following designated tasks:

001 Waste Utilization for the Generation of Methane Gas
002 Energy Conservation in the Poultry Industry
003 Solar Energy Application to the Poultry Industry
004 Mechanization of Whole Bird Packaging in Poultry Processing

Project 001

Final check-out of the digester and ancillary systems was completed. Loading has commenced but is slow due to limited water supply. We are running the digester at a volume of 8400 gallons at a 10% v/v loading of raw manure. This level of loading was selected to avoid major material handling problems and to provide favorable chemical conditions. The experiment will be run at 98°F (mesophilically) and at reduced pressure (hypobarically) at -3 psig. It will be run in the well-stirred mode using the recirculation pump for agitation. Induction will be accomplished using in-situ bacteria.

Project 002

The energy audit data evaluation for processing plants has been completed and a copy is enclosed. Ten plants responded to the survey out of eighteen survey forms mailed. These survey results have been compared to 1974 survey results and the most obvious trend has been that the energy use in Georgia broiler processing plants has been reduced significantly from 1974 to 1976, but energy costs have actually risen.

Energy audit forms for hatcheries, feed mills and egg processing plants are presently being mailed. A modified survey form will be sent to broiler growout managers to compile energy data on broiler growout operations.

The existing monitoring programs for energy conservation in broiler house lighting and fan operation are continuing.

Project 003

The solar system will be used only briefly over the summer months. We have therefore removed the recording thermometers to check and recalibrate them. One of the recording thermometers needs to have a new sensing element installed. This will be done and both instruments will be replaced in the fall.

We are proceeding to find a partner for the extended roof hot air collector project and anticipate beginning this design effort within the next few weeks.

Project 004

The Altenpohl representatives met with the Mar-Jac and Marell representatives in order to begin negotiation and site selection for the installation of the whole bird packaging machine. The facilities of each plant were toured and some initial data regarding line speeds, line orientation and available space were acquired. The Altenpohl people were most impressed with the Mar-Jac plant as the first installation site because of the simplicity of the lines. The Marell plant, while not having any unusual problems, used two lines feeding one packing hopper which could potentially jam the packing machine with two birds at one time.

Plans were made for an inspection of the new model packing units by representatives from the EES and Mar-Jac. Subsequent work will assist in detailed measurement of the packing area and a new layout of the conveyor to better fir the machine requirements.

Please note that this is the final monthly report for Project A-1879 and the final report will be forthcoming after July 31, 1977.

Respectfully Submitted,

James F. Lowry
Program Manager

R. L. Yobs
Lab Director

CODE #	ELEC. USE (KWH)	ELEC. COST ($)	NAT. GAS (THERMS)	NAT. GAS COST ($)
010002	12654800.	314088.	1127918.	159285.
010003	8275500.	219888.	252321.	43444.
010005	8343920.	217493.	395377.	51571.
010007	3133370.	92007.	122410.	15730.
010009	4651200.	126841.	0.	0.
010010	7041600.	196295.	613697.	80894.
010011	3813200.	134460.	326002.	44372.
010012	7462500.	199046.	672304.	37972.
010013	5964000.	166210.	285980.	37383.

CODE #	PROP. (GAL)	PROP. COST ($)	FUEL OIL (GAL)	FUEL OIL COST ($)
010002	0.	0.	655358.	221786.
010003	0.	0.	110560.	38541.
010005	2376.	3135.	107810.	34883.
010007	0.	0.	13845.	4995.
010009	40545.	14073.	270257.	93899.
010010	0.	0.	0.	0.
010011	0.	0.	0.	0.
010012	0.	0.	107296.	38377.
010013	0.	0.	137209.	37899.

CODE #	ELEC. USE (BTU)	NAT. GAS (BTU)	PROP. (BTU)	FUEL OIL (BTU)
010002	43190832400.	112791800000.	0.	95026910000.
010003	28244281500.	25232100000.	0.	15412064000.
010005	28477798960.	39537700000.	218592000.	15028714000.
010007	10694191810.	12241000000.	0.	1929993000.
010009	15874545600.	0.	3730140000.	37673825800.
010010	24032980800.	61369700000.	0.	0.
010011	13014451600.	32600200000.	0.	0.
010012	25469512500.	67230400000.	0.	14957062400.
010013	20355132000.	28598000000.	0.	20499024600.

CODE #	ELEC. USE (KWH)	ELEC. COST ($)	NAT. GAS (THERMS)	NAT. GAS COST ($)
010002	12654800.	314088.	1127918.	159285.
010003	8275500.	219888.	252321.	43444.
010005	8343920.	217493.	395377.	51571.
010007	3133370.	92007.	122410.	15730.
010009	4651200.	126841.	0.	0.
010010	7041600.	196295.	613697.	80894.
010011	3813200.	134460.	326002.	44372.
010012	7462500.	199046.	672304.	37972.
010013	5964000.	166210.	285980.	37385.

CODE #	PROP. (GAL)	PROP. COST ($)	FUEL OIL (GAL)	FUEL OIL COST ($)
010002	0.	0.	655358.	221786.
010003	0.	0.	110560.	38541.
010005	2376.	3135.	107810.	34883.
010007	0.	0.	13845.	4995.
010009	40545.	14073.	270257.	93899.
010010	0.	0.	0.	0.
010011	0.	0.	0.	0.
010012	0.	0.	107296.	38377.
010013	0.	0.	137209.	37899.

CODE #	ELEC. USE (BTU)	NAT. GAS (BTU)	PROP. (BTU)	FUEL OIL (BTU)
010002	43190832400.	112791800000.	0.	95026910000.
010003	28244281500.	25232100000.	0.	15412064000.
010005	28477798960.	39537700000.	218592000.	15028714000.
010007	10694191810.	12241000000.	0.	1929993000.
010009	15874545600.	0.	3730140000.	37673825800.
010010	24032980800.	61369700000.	0.	0.
010011	13014451600.	32600200000.	0.	0.
010012	25469512500.	67230400000.	0.	14957062400.
010013	20355132000.	28598000000.	0.	20499024600.

CODE #	ENERGY (BTU)	COST ($)	BTU/1000 LBS	BTU/1000 BIRDS
010002	251009542400.	695159.	1544532.	5844091.
010003	68888445500.	301873.	984121.	3444422.
010005	83262804960.	307082.	1284920.	3401397.
010007	24865184810.	112732.	783254.	2238292.
010009	57278511400.	234813.	867856.	2545712.
010010	85402680800.	277189.	1278445.	3541182.
010011	45614651600.	178832.	1126037.	3131154.
010012	107656974900.	275395.	1708841.	4255216.
010013	69452156600.	241494.	1269135.	3530688.

CODE #	$/1000 LBS	$/1000 BIRDS	1000 LBS/EMPLOYEE	1000 BIRDS/EMPLOYEE
010002	4.278	16.185	R	R
010003	4.312	15.094	175.000	50.000
010005	4.739	12.545	129.600	48.958
010007	3.551	10.148	171.600	60.047
010009	3.558	10.436	282.051	96.154
010010	4.149	11.494	167.844	60.595
010011	4.415	12.276	147.305	52.975
010012	4.371	10.885	210.000	84.333
010013	4.413	12.277	119.746	43.044

CODE #	BTU/EMPLOYEE	$/EMPLOYEE
010002	R	R
010003	172221114.	755.
010005	166525610.	614.
010007	134406404.	609.
010009	244779963.	1003.
010010	214579600.	696.
010011	165871460.	650.
010012	358856583.	918.
010013	151974084.	528.

1

	ELEC. USE (KWH)	ELEC. COST ($)	NAT. GAS (THERMS)	NAT. GAS COST ($)
0	61340090.	1666328.	3796009.	470653.

	PROP. (GAL)	PROP. COST ($)	FUEL OIL (GAL)	FUEL OIL COST ($)
0	42921.	17208.	1402335.	470380.

	ELEC. USE (BTU)	NAT. GAS (BTU)	PROP. (BTU)	FUEL OIL (BTU)
0	209353727170.	379600900000.	3948732000.	200527593800.

1976 GROSS INDUSTRY SAMPLE INFORMATION

	ENERGY USE (BTU)	ENERGY COST ($)	PRODUCTION (1000 LBS)	BIRDS (X 1000)
1	793430952[illegible]70.	2524569.	620098.	204570.

1976 AVERAGE INDUSTRY SAMPLE INFORMATION

ENERGY USE (BTU) ENERGY COST ($) [illegible]

A-1879

FINAL REPORT

PROJECT A-1879

POULTRY WASTE UTILIZATION
ENERGY CONSERVATION IN THE GEORGIA POULTRY INDUSTRY
APPLICATION OF SOLAR ENERGY TO BROILER HOUSE HEATING
MECHANIZATION OF WHOLE BIRD PACKAGING

by

C. Bronn, R. S. Combes, J. F. Lowry
Dr. D. J. O'Neill, A. D. Poulin
J. Wood

Engineering Experiment Station
Georgia Institute of Technology
Atlanta, Georgia 30332

August 1977

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the assistance and continued support of the Georgia Poultry Industry, without whose direct efforts this work would not have been accomplished. We wish to thank broiler growers and broiler processors in particular for allowing modifications to be made to their facilities for demonstration of solar energy and conservation techniques.

SUMMARY

Research into the technical improvement of the Georgia poultry industry is a continuing program at the Engineering Experiment Station (EES) at Georgia Tech. This report covers efforts expended under Research Project A-1879 from August 1, 1976 through July 31, 1977. As several of the projects are long term programs this report will cover the work since the final report on Research Project A-1771. Work is continuing under Research Project A-2028. Each of these projects is discussed in this report.

Because of a depressed gas production rate, the 10,000 gallon digestor located on a layer farm in Cumming, Georgia was modified to operate in three additional modes of operation. These are the "well stirred tank reactor", "bottom loading reactor" and "above exhaust reactor". It is anticipated these will allow for a greater microbiological mass which will allow a much greater gas production. The digestor is currently undergoing incubation in preparation for testing during Research Project A-2026.

Energy conservation efforts continued with the dissemination of energy conservation information developed during the current and previous research projects to members of the Georgia poultry industry. Emphasis was placed on egg processing, broiler growout, and rendering for further analysis work and this information was applied to various facilities throughout the state. An additional audit of energy use in the industry was conducted and it was found that energy use is decreasing, although overall costs continue to rise.

During Research Project A-1879, a low-cost solar heating system was installed on a broiler growout house and operated through the winter of 1976-1977. It was found that the solar heated house required 47% less purchased fuel than the control houses. A new design for a more universally applicable system is currently under development and will be demonstrated in the forthcoming research program.

Mechanization studies centered on the whole bird packaging system, with complete analysis of all components of the process. A commercial, partially developed whole bird packaging machine was found, improved and aided in its development and is currently undergoing testing in a Georgia poultry facility. It is expected this will be available to all processors within the next few months with excellent operating economics.

INTRODUCTION

The activities included in Research Project A-1879 were conducted by the Engineering Experiment Station (EES) at Georgia Tech for the Georgia Department of Agriculture under a continuing program for the technical improvement of the Georgia poultry industry. Research Project A-1879 covers the efforts expended from August 1, 1976 through July 31, 1977. These research efforts were conducted under the general direction of the Georgia Poultry Federation and the project direction and results were monitored by the Research Committee of the Georgia Poultry Federation. This committee is made up of leaders from various segments of the industry.

Research Project A-1879 included four primary tasks:

1) Laboratory and pilot scale studies of the utilization of poultry manure to generate synthetic natural gas (methane) and an effluent of increased value
2) Energy conservation demonstrations in the poultry industry
3) Application of solar energy to broiler house heating
4) Mechanization of whole bird packaging in poultry processing

Waste Utilization

The poultry waste utilization research was a continuation of efforts begun during Research Project A-1659 and continued through Research Project A-1771. Future research will be conducted under Research Project A-2028 This poultry waste utilization work has been documented through August, 1976 in the final reports for Research Projects A-1659, A-1737, and A-2028. This report will contain the information generated from August, 1976 through July 31, 1977.

The purpose of this program is to study the anaerobic digestion of poultry waste with the goal of optimizing the quality and quantity of both the generated synthetic natural gas and the liquid and solid effluent. As a result of previous laboratory work, it was determined that a pilot facility located on an operating layer farm would be required to acquire meaningful data to be applied to a full-scale operating system. A 10,000 gallon digestor with associated materials handling equipment was constructed on a layer farm in Cumming, Georgia during the winter of 1975-1976. This facility is described in the final report for Research Project A-1737.

During March and April 1976 the digestor was loaded with feedstock consisting of 30% raw layer manure and 70% water by volume after initial additions of 50/50 mixes proved to be too viscous. Ten gallons of cattle manure were added as seed material and the digestor was allowed to incubate at 90°F for the next 60 days. In this incubation process the population of anaerobic bacteria multiplied to fill the entire digestor using the manure as a food source. At the end of this period a gas production rate of 22 cubic feet per hour was achieved, with the quality reaching 77% methane and 23% carbon dioxide. This gas production rate was disappointing. However, materials handling problems dictated an extended loading period and required intermittent removal of solids which probably reduced the food source for the bacteria. The high percentage of methane did prove that poultry manure is a good food source for methanogenic bacteria cultures.

Continuous, daily unloading of effluent and replacement with feedstock was begun after the incubation period was complete. However, a steady state equilibrium condition was not achieved. Because of depressed gas production and because of the results of several laboratory tests, it was decided to modify the pilot facility to operate in three additional modes of operation. These are the "well stirred tank reactor", "bottom loading reactor" and "above exhaust reactor". These last two modes use the settling characteristics of the dispersed solids to give a greater microbiolgical mass and hopefully a greater gas production rate. These modifications are complete and the digestor is currently in its incubation stage for further testing of the process.

Concurrently with the pilot facility work, laboratory experiments were being conducted to better understand the mechanics inside the digestor. Several studies were made to determine the value of seeding the digestor with cattle manure and it was found not to be needed. Sludges from these tests were analyzed and found to have a low value as a non-ruminant feed.

Energy Conservation

During Research Project A-1737 an energy audit of the Georgia poultry industry was conducted because of the increasing cost and unavailability of fuels normally used. This audit resulted in a definition of the fuels used and of the processes in which they were used. It became obvious that there was no less expensive substitute for the normally used natural gas than the fuel oil that is currently being substituted. Therefore this study recommended that immediate action be taken by the industry to modify equipment and operations to reduce energy consumption. As a result of this recommendation, a program to study each process, develop energy reduction plans and demonstrate energy saving modifications in various industry facilities was initiated in Research Project A-1771. Several of these demonstrations were continued and monitered during Research Project A-1879.

For Research Project A-1879, additional engineering studies consisted primarily of egg processing and rendering operations. The major effort of the project was to make the demonstrated modifications known to members of the industry and to assist them in implementing such modifications in their facilities. This was accomplished by plant visits, meetings and seminars.

During this year's program another energy use audit was conducted of the industry. This indicated that although energy consumption was generally down, the total cost of energy was greater than in 1974. A most notable fact developed by the audit was that one processing facility had reduced its energy consumption by 28% since 1974. As might be expected, this is the most energy conscious plant and the one that has spent more time, money and effort in improving its operation energy-wise. These efforts have been rewarded with demonstrated energy and dollar savings.

Solar Broiler House

A new program undertaken during Research Project A-1879 was to evaluate the use of solar energy as a heating medium for the broiler grow out house. To accomplish this, an intergrated solar collector/storage system was installed at a broiler house in Cumming, Georgia in partnership with Wilson Foods, Inc. This system, using air as the collection and heating medium and rock storage, is estimated to cost $3,500, and can be constructed by the grower. During the winter of 1976-1977 this system demonstrated an energy saving of 47% as compared to the control houses using conventional natural gas. It is anticipated that during the coming program an improved design will be demonstrated, with a goal of saving 75% of the energy required from fossil fuels.

Mechanization Studies

The study of poultry processing mechanization was directed to the area of whole bird packaging for Research Project A-1879. This study included those operations occurring after the product is removed from the chill tank until it is in storage or in the transportation trailer. These processes include sizing, packing in boxes, labeling, installing ice or carbon dioxide, installing a top on the box, palletizing and transporting to the awaiting facility.

During the project a thorough study was made of each individual process and each function within the process. From this the required and extraneous functions were determined and equipment was defined to perform the required functions. Except for the actual placing of the birds in the box, it was found that existing operations are as economically beneficial as an optimumly automated system under existing marketing and space constraints.

In the process of studying equipment for packaging whole birds into boxes, a company in North Carolina was discovered that was in the process of developing such a device. After much study it was determined that with a few modifications this device would perform this operation. During the year the first prototype was tested in a processing facility and improved to continuous duty capability. Subsequently the first production model was installed in a Georgia facility and successfully operated to the satisfaction of the company. It is expected that these will be made available to all processors in the state through the EES report and the normal marketing efforts of the company.

I. POULTRY WASTE UTILIZATION

One of the continuing problems associated with the poultry industry is the disposal of manure generated by the birds during their growing and/or laying period. Sources from the available literature give a wide range of manure production, but a reasonabable range appears to be between 0.2 and 0.3 pounds per bird each day. With current poultry population figures and the above waste production estimate, approximately 11,500 to 14,000 tons of fresh manure are produced in Georgia each day. Generally, this manure is disposed of by spreading upon pastures, crops, gardens, etc. and allowing for natural decomposition and leaching into the soil. In this form it is used as a soil supplement which is, at best, a low return operation for the grower. This method is beginning to experience social and environmental resistance that is sure to increase in the future. Additionally, manure handling is generally a net cost operation.

During Research Project A-1659, initial laboratory experiments were conducted to study the feasibility of utilizing poultry manure as the feedstock for an anaerobic digestor. This digestor, using bacteriological fermentation, would in turn produce a synthetic natural gas (methane), carbon dioxide, solid effluent and liquid effluent. The laboratory experiments provided sufficient data to justify the need for further experimental work. This additional effort has taken the form of continuing laboratory studies and pilot plant studies. The pilot plant studies are being conducted using a 10,000 gallon digestor and associated materials handling equipment constructed on a layer farm in Cumming, Georgia. Basic details of this facility are contained in the final report for Research Project A-1737.

The overall purpose of this anaerobic digestion research is to determine an optimum practical mode of operation for an on-site digestor and then to develop the economics of such an operation. From this can be developed the economic feasibility of such a concept. Preliminary studies based on laboratory production rates indicate the process will be economically feasible but many factors must be accurately determined before a final economic determination can be made. As noted in the final report for Research Project A-1737, the pilot digestor construction was completed in the Spring of 1976. and operations proceeded through the Summer of 1976 with two objectives.

One objective was to operate the digestor in a plug-flow mode and to obtain synthetic gas generation, methane composition and materials handling data. The second objective was to continue laboratory studies of various solids loadings, solids settling rates and solids dispersion to determine optimum conditions for anaerobic fermentation.

Pilot Plant Studies

As reported in the Final Report for Research Project A-1771, initial operation of the pilot facility resulted in the production of gas containing 77 percent methane, extremely low production rates of 22 cubic feet per hour and a multitude of material handling problems. During this reporting year, equipment modifications were made to alleviate these materials handling problems and the pilot facility is currently working very well.

During these modifications and because of the low gas production rates experienced in the plug-flow mode of operation, it was decided to modify the pilot facility to operate in three other modes of operation. These are the "well-stirred tank reactor", "bottom loading reactor" and "above exhaust reactor" modes. As detailed in the A-1771 Final Report, the plug-flow reactor is most efficient; however, settling greatly reduces its efficiency. The well-stirred reactor mode reduces the effect of settling but is energy intensive because of the pumping requirement.

The settling, however, may actually work to the economic advantage of the system. Since it appears that the digestion process occurs within the volume of the sludge, and since laboratory tests indicate the amount of water used in solids dispersion is not critical after initial mixing as long as the particles were dispersed, the settling may allow the entire volume of the digestor to be used instead of the 30-50 percent now used. The two additional "bottom loading reactor" and "above exhaust reactor" modes were incorporated within the digestor system to take advantage of the settling.

Both modes essentially inject feedstock into the digestor and remove the supernatant or added water until the digestor is full of solids with a 70-80 percent by weight water content. Laboratory tests show that the dispersed manure in a diluted mix will settle back to its orginal volume-that is, the same volume as the raw manure originally added. Therefore, the digestor's throughput and products could be increased three-fold for a given digestor size.

The "bottom loading reactor" mode loads the digestor at the bottom as opposed to the "plug-flow reactor" mode which loads from the top. Settling is allowed to occur. As the settled sludge moves up it is discharged at the top of the digestor. Occasionally, the digestor will be discharged at the bottom to remove accumulated tramp material. The "above exhaust reactor" mode loads at the top of the digestor as in the "plug-flow reactor" mode; however, settling is allowed to occur. The separated water is then removed from the top. The settled solids move downward with each subsequent addition and eventually discharge at the bottom. The separated water may be used for the next slurry batch, which conserves water and heat. Also, tramp material is removed at the bottom of the digestor with each discharge. The overall hydraulic system is shown in Figure 1.

During the pilot facility modifications a number of operational improvements were made, the principle one being the ability to periodically backflush the plumbing. When clogging has occured, the plumbing is backflushed, thereby unclogging the system without dismantling the system, as was done during previous digestor loadings. The new design has also overcome the clogging that occurred during each sludge discharge with the original system. Now, the sludge is immediately diluted with water as it leaves the digestor. Diluting the sludge and grit reduces appreciably the possibility of clogging the system. In the event clogging should occur during discharge, backflushing will clear the system.

Since the number of operational modes has been increased from two to four, additional equipment was introduced into the existing system. This included the new valves, motors, level control switches, pressure switches and timers. A programmed stepping relay mounted in the control panel controls the above equipment for different operations such as discharging, loading, circulating, etc. The control panel shown in Figure 2 has a schematic of the system and appropriately placed indicator lights continually showing the flow throughout the system.

Sight-flow gauges have been incorporated in the plumbing and plexiglass access port on the digestor allows for visual monitoring of activity in the digestor.

The modified plant digestor was hydrostatically tested for leaks and for equipment testing and was ready for loading on July 5, 1977. Loading was completed by July 21, 1977. This digestor is currently incubating.

For this first set of experiments, the digestor will operate in the "well stirred tank reactor" mode. The initial feedstock concentration will be ten percent by volume and the feedstock concentration will gradually be increased until either the equipment can not pump the feedstock or the gas rate no longer increases. The retention time, which will be kept constant during the concentration variations, will then be decreased until the gas rate and biomass production rate drop off appreciably. Economic considerations dictate that the digestor be operated at the highest concentration and the shortest retention time possible for maximum gas and biomass production.

Laboratory Studies

During the modification of the pilot digestor, experiments in 5 gallon digestors were conducted to determine the value of seeding the digestors with cattle manure as a source of bacteria prior to incubation. To study this phenomena, five gallon digestors were operated hypobarically at 3 psig and under various temperature and concentration conditions, and the gas flow rates, induction time and other parameters were measured. The conditions of operation and results are shown below in Table I.

TABLE I

Results of No-Seeding Tests

Five Gallon Digestors

Concentration % v/v	10(90°F)	20(90°F)	30(90°F)	40(90°F)	40(140°F)
Total Gas, $ft.^3$	6.60	4.73	10.6	21.1	4.59
Total Methane, $ft.^3$	4.34	2.08	5.69	12.4	0.742
% Methane	66	44	53	59	21
Incubation time, days	41	55	48	24	(toxic)
Maximum Rate v gas/v reactor/hr.	.037	.029	.058	.055	.004
$ft.^3$/lb. vol. solids	10.1	3.60	5.44	8.09	1.76

The results indicate that the variability in total gas yield per pound of volatile solids and incubation time is independent of concentration despite the preparation from the same batch of manure and the same time of preparation. These results agree with prior experiments. No acceptable explanation exists at the moment other than that the fermentation process is a delicate one.

The total gas yield per pound of volatile solids for the 10% and 40% v/v concentrations agree with literature values. The methane percentages are an average for the 82 days. The percentages run at 75% following the incubation period unless the digestor has gone toxic. The 40% slurry gave the best overall performance. The important result is that seeding with cattle manure is not required.

Sludges were isolated after the experiments from the 10% and 20% by volume digestors for analysis. Table II below lists the results. The pepsin digestible protein test indicates a low value as a non-ruminant feed.

TABLE II

Results of Sludge Analysis
Five Gallon Digestors

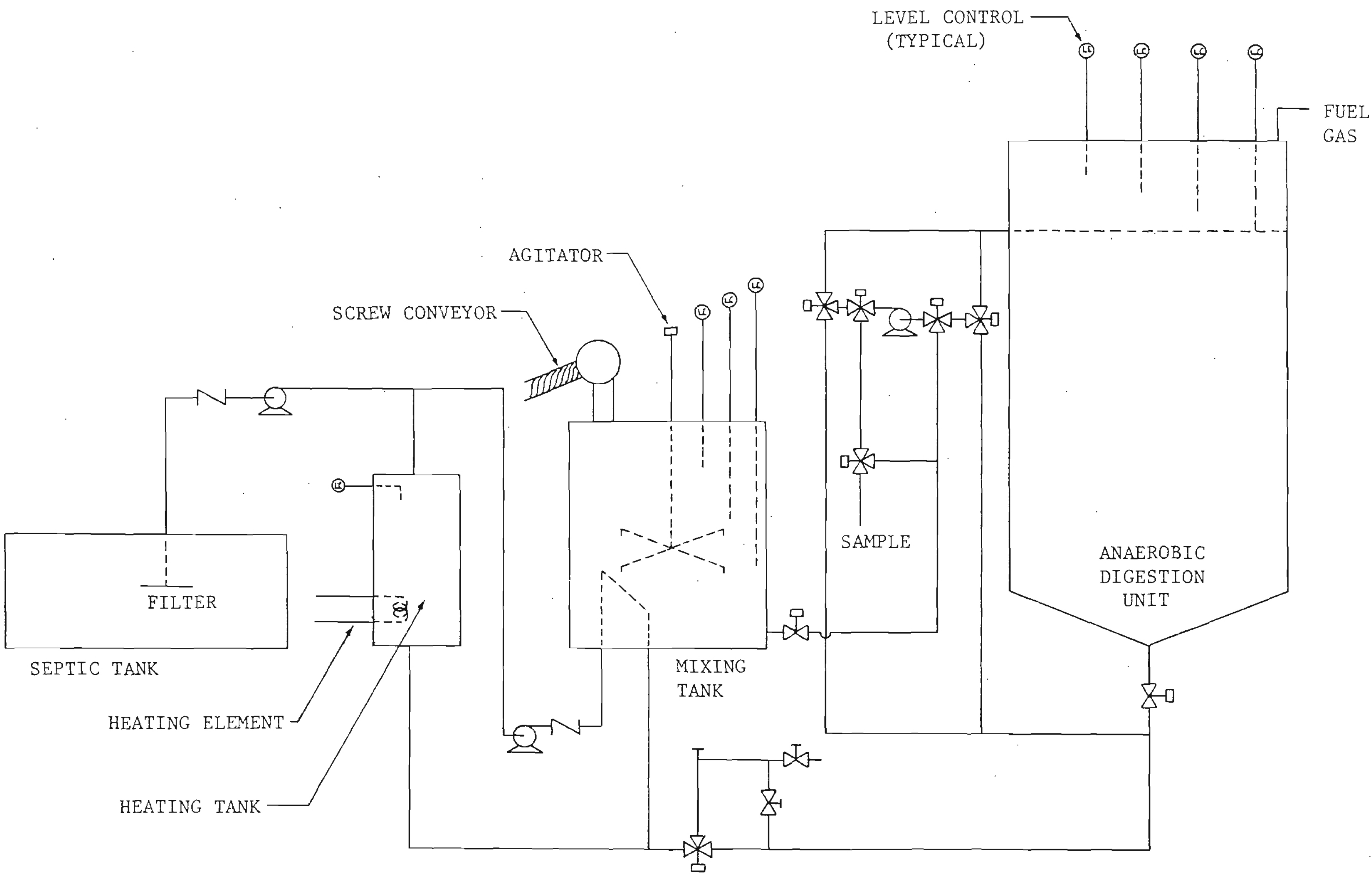
	10%	20%	Typical Chicken Feed
Moisture, %	3.1	15.0	
N,%	1.85	1.59	
N (as protein), %	11.56	9.44	15
*Digestible Protein (Pepsin), %	2.51	1.00	13
P_2O_5, %	13.81	8.86	3.0
K_2O, %	0.77	0.38	0.6
Crude Fiber, %	15.38	13.24	5

Before proceeding with the pilot plant modifications to include the four modes of operation, viscosity measurements on digested manure were made. The viscosity measurements were made on the contents of the four five-gallon fermenters. More specifically, the samples were the sludges at the bottom of the fermenters obtained by decanting the supernatant liquid. The nominal concentrations of the fermenters were 10, 20, 30 and 40 percent by volume. Figures 3 and 4 show the results for undigested and digested manure, respectively. A Thomas-Stormer viscometer was used for the measurements.

The measurements indicated that digestion reduced the viscosity of poultry manure slurries. The highest viscosity measured following digestion was 567 centipoise for a 75 gram shear force. This value was far less than the infinite viscosities observed at low shears for undigested, completely suspended slurries for the above concentrations. Also, the rheological properties approach ideal Newtonian behavior during digestion.

A relationship, Figure 5, between undigested slurry concentration and the viscosity of extrapolated infinite shear force was applied to the measurements of the digested sludge samples. This relationship was discovered during earlier work. The determined concentrations were 15, 25, 34, 37% by volume respectively. In other words, the respective sludges appeared to have the above concentrations as if they were undigested slurries. It can be concluded that infinite compaction of the sludge into "cement" does not occur even after five months of compaction time.

The studies have shown that the viscosities of the slurries decrease significantly during digestion, that the rheological properties of the slurries approach Newtonian behavior during digestion, and that compaction of the slurries is limited. These results indicate that operation of the pilot plant in the "above exhaust reactor" and "bottom loading reactor" is feasible.



ANAEROBIC DIGESTION OF CHICKEN-MANURE

Figure 1. Digestor Hydraulic System

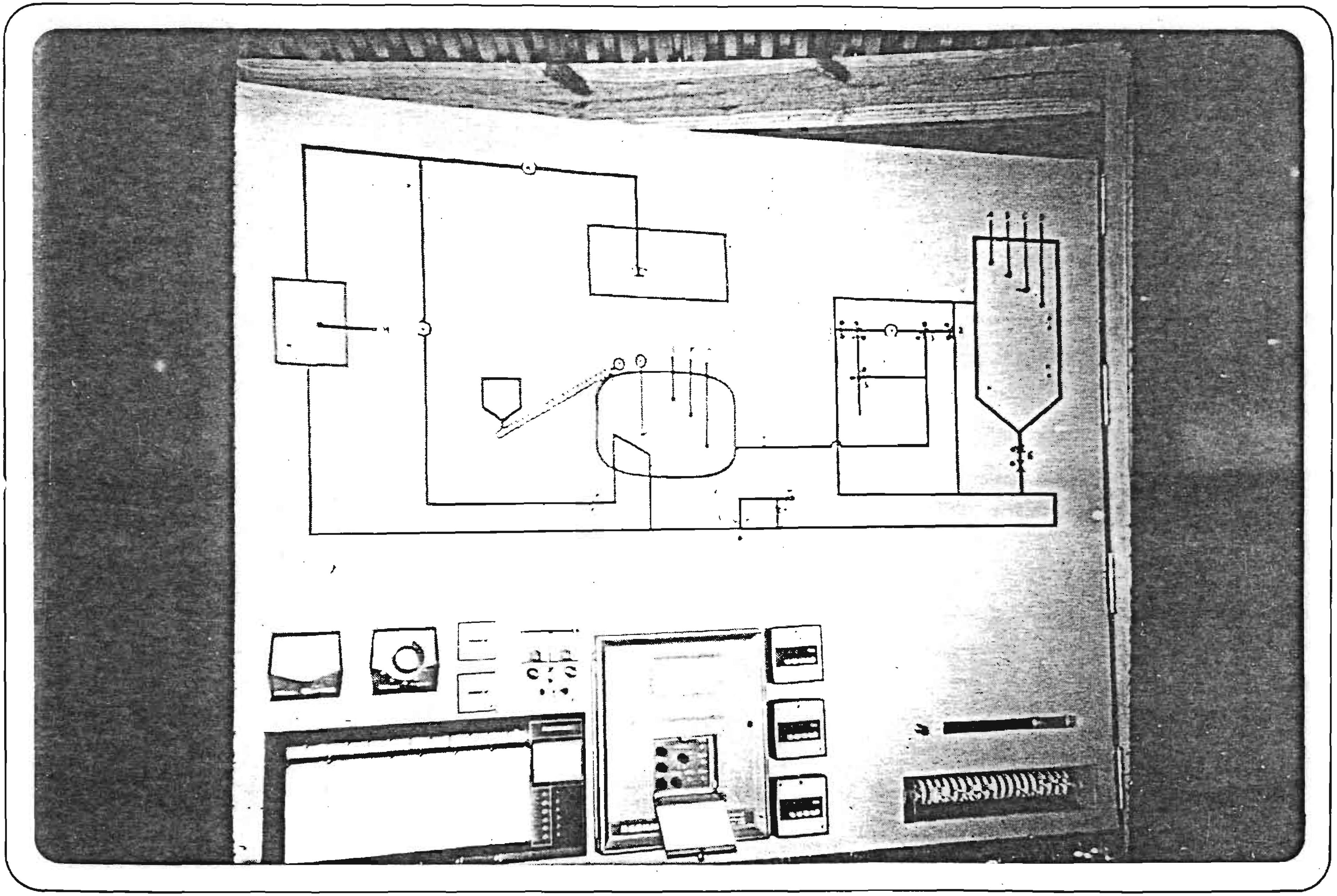


FIGURE 2 Digestor Control Panel

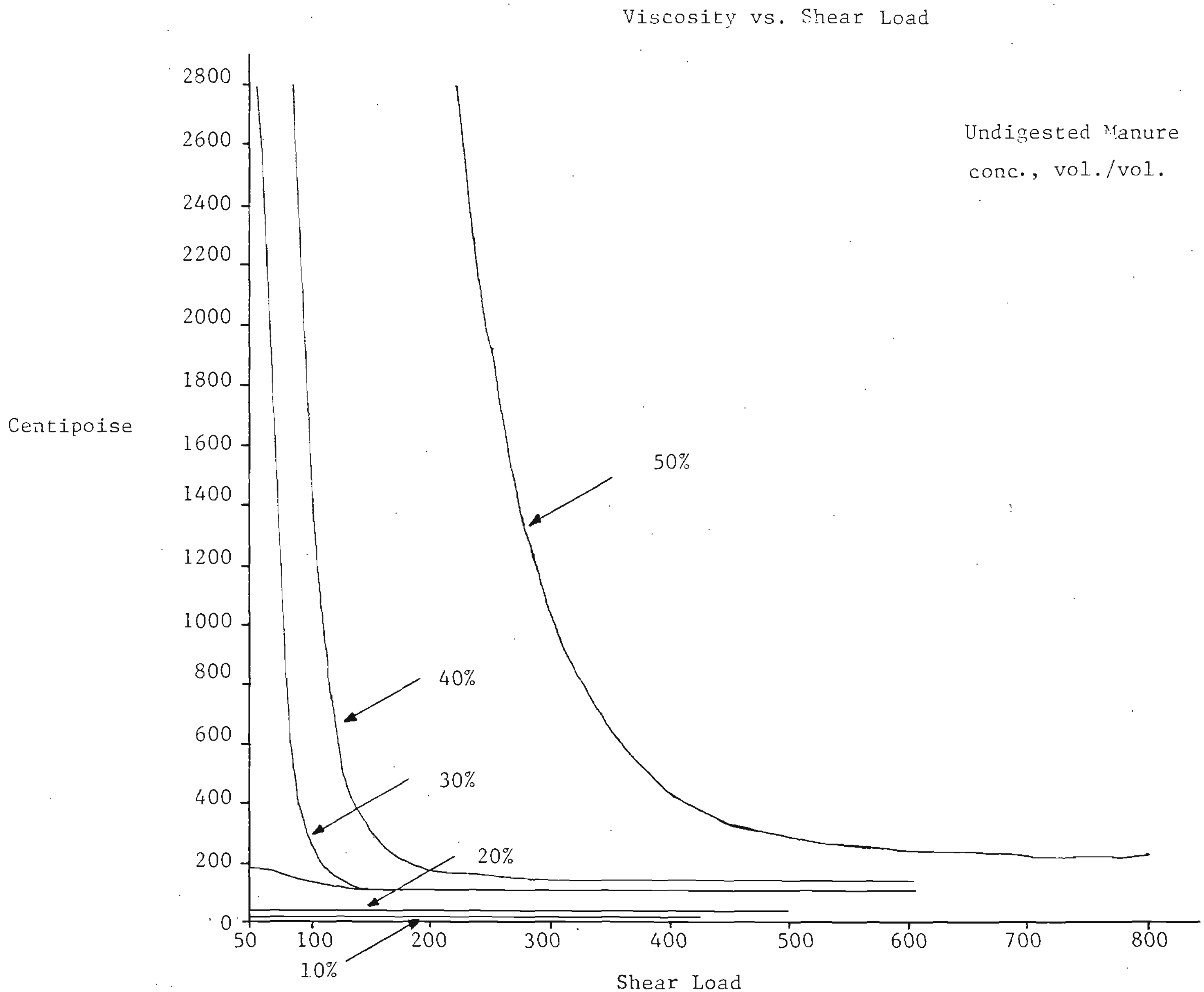


FIGURE 3 Viscosity versus Shear Load
in Undigested Manure

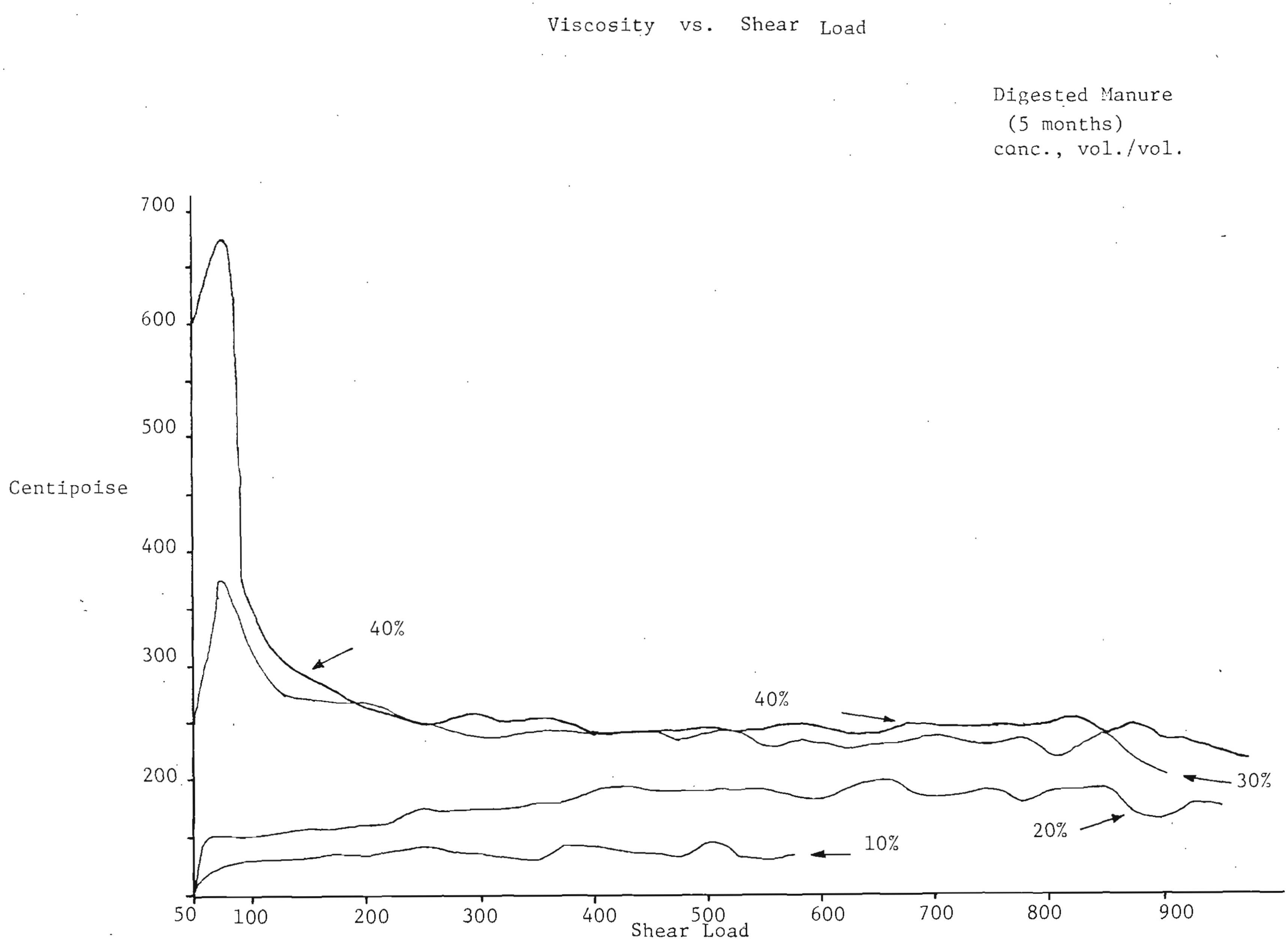


FIGURE 4 Viscosity versus Shear Load in Digested Manure

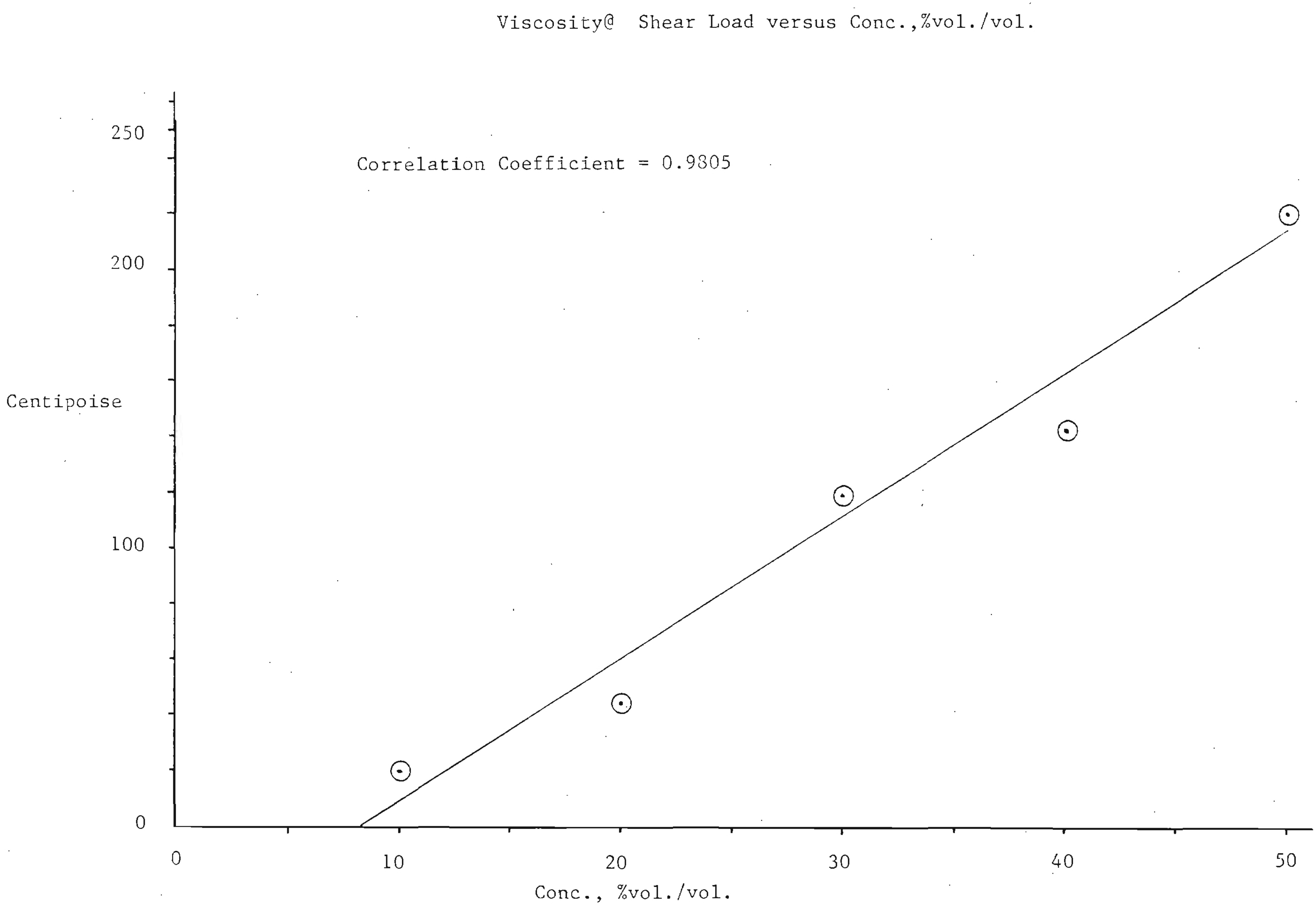


FIGURE 5 Viscosity versus Concentration

II. ENERGY CONSERVATION IN THE GEORGIA POULTRY INDUSTRY

The energy conservation program for FY 1977 was a continuation of the program initiated in FY 1976. The previous program dealt with engineering analyses of the various sectors of the poultry industry, and was directed to formulating energy conservation measures which are technically and economically feasible to adopt in the various operations of the poultry industry. The sectors of the industry which were evaluated included broiler growout, broiler processing, poultry rendering, feed mills, hatcheries, egg production and egg processing. For FY 1977, engineering studies of industry operations concentrated primarily in egg processing and rendering operations. This program consisted mainly of dissemination of the energy conservation recommendations to industry members and the further demonstration of selected recommendations. This dissemination was accomplished by visits to facilities and farms to acquaint the industry management and growers with the results of the sponsored research, and to suggest possible means of saving energy at specific facilities. Additional engineering assistance was provided in the form of more detailed reports when greater depth of study was requested by an industry member. In addition, presentations were made at several poultry industry seminars throughout the year.

Industry Energy Consumption

In the spring of 1975, a survey of the industry energy usage was made to establish baseline data for industry energy consumption. Using these data, a measure of the effectiveness of the energy conservation program was established. In the spring of 1977, the energy survey was repeated and a summary of comparative results for industry energy consumption in 1974 and 1976 are presented in Table III.

TABLE III
Energy Audit Results

Industry Sector	1974	1976	% Change
Broiler Processing	4090 BTU/bird	3876 BTU/bird	- 5%
	$0.011/bird	$0.0128/bird	+ 20%
Egg Processing	226 BTU/dozen	218 BTU/dozen	-3.5%
	$0.002/dozen	0.0021/dozen	+ 5%
Feed Mills	270,200 BTU/ton	220,000/ton	-18.5%
	$0.92/ton	$0.763/ton	- 17%
Hatcheries	377 BTU/chick	384 BTU/chick	+ 2%
	$0.00197/chick	$0.00204/chick	+ 3.6%

Of the sample of facilities responding to the survey, it is apparent that energy conservation has been implemented to some degree. Energy savings resulting from conservation efforts are due primarily to better "housekeeping" practices rather than extensive process or equipment modifications, and it is anticipated that substantial energy savings are still possible with some investment of capital. For instance, one broiler processing plant in Gainesville, Georgia has cooperated with EES research personnel on several demonstration projects of energy conservation modifications, and has reduced energy consumption levels from the 1974 levels by 28%, which represents the highest percentage reduction of any of the plants surveyed. However, in order to realize this level of savings, this company made a significant capital investment in energy conservation modifications. This fact points up the greatest obstacle to implementation of energy conservation modifications - the initial investment. In the poultry industry, as in other industries, there is a reluctance to invest in energy conservation, if the alternative is to invest in production improvements. The prevailing philosophy in a large portion of the industry views energy conservation as an intangible benefit which exhibits patriotic appeal rather than a sound business practice. Based on this philosophy, this year's poultry energy conservation program has consisted to a large degree of evaluating available energy conserving equipment, such as heat recovery systems, and providing technical backup for a feasibility study of the equipment. Even so, industry investments in energy conservation remain small, due in part to the depressed condition of the broiler market over the last year. In order to overcome this reluctance, the energy conservation program for FY 1978 will be directed to more specific demonstration programs which will be documented and the results disseminated throughout the Georgia industry.

The specific work performed in the various sectors of the industry over the last year is detailed in the sections below.

Poultry Housing

The major consumers of energy in poultry housing have been identified as heating systems, ventilation systems and lighting systems.

Heating Systems: In addition to the parallel work being performed by EES in the area of solar heating, an assessment of conventional brooding systems was performed. Twelve manufacturers of gas-fired brooders and one manufacturer of electric brooders were surveyed and, where possible, performance data were collected to make a comparison of different types of brooders. In addition, previous research results were surveyed to assist in evaluation of brooding systems. The results of this survey are as follows:

1) A significant portion of gaseous fuel is consumed by the pilot light. Pilot light usage accounted for approximately 10% of total brooder fuel on the average and reached as high as 18% of the total gas consumption.
2) Gas brooder control systems (temperature sensor, solenoid valve and orifice) account for a wide variation in the efficiency of providing heat.
3) Radiant heating seems to be preferable to convective heating from the standpoint of energy conservation.
4) An open flame gas brooder accounts for a significant amount of moisture being added to the air in a poultry house.

One gas-fired infrared heating system was found which seems to have the potential for an estimated fuel savings of up to 35% over conventional brooders. This system, manufactured by the Roberts Gordon Appliance Corporation, uses an electric spark ignition and claims very high (93%) combustion efficiency. In addition the products of combustion (water, carbon dioxide and other gases) are vented outside the building. The company claims excellent results in a test performed several years ago in a poultry house. The primary drawback of this system is the high cost - approximately 3-4 times the cost of conventional brooders.

After the natural gas shortage in the winter of 1976-1977 which also affected propane supplies, the project personnel felt it expedient to turn efforts in energy conservation in brooding to finding an alternate fuel for heating systems. An efficient wood or coal fired heating system which provided the convenience and reliability of the existing gas brooders was sought. There are several forced air heating systems which are currently marketed and which are being evaluated for use in a poultry house. It is planned that a solid fuel brooding system be designed and installed on a poultry house during the coming year's energy conservation program.

Ventilating Systems: As is the case with commercially available gas brooders, a wide variation in energy efficiency exists in commercially available ventilation fans for animal shelters. However, an economic evaluation of any ventilating fan must consider both initial cost and operating cost over the expected life of the fan. In attempting to make such an evaluation on a ventilating system, a critical factor in determining operating costs is the utilization factor of the fans. Therefore, a monitoring program was initiated in which the fans in a broiler house in Cumming, Georgia were instrumented and monitored for total run time over a year's period. Table IV presents the results of this monitoring program and a sample calculation of an economic evaluation of a fan system for a typical side curtain house.

TABLE IV

Poultry House Ventilating Fan Monitoring

Program Results

Poultry House	11,000 broiler capacity 5 - 36 inch, 1/2 HP fans	
Monitored Fan Utilization		
Factor Over 11 Months	18.11%	
Sample Economic Evaluation of Two Types Fans		
Assume above fan system, considering two available fans of different manufacture:		
	Fan A	Fan B
Initial Cost (5-36 inch fans)	\$2400	\$1350
Ventilating Efficiency Ratio (Meters^3/see-watt)	0.0090	0.0059
Annual Operating Cost w/electric cost of 4¢/KWH. 18.11% utilization factor	\$166	\$254
Annual Savings w/Fan A	\$ 88	
Net Savings over 10-year life of fans, w/utility costs increasing @ 14% per annum	\$1702	
This equals the initial additional investment of \$950 invested at 6% per annum for 10 years.		

This investment procedure will be written up and distributed to broiler growout managers throughout Georgia. For the FY 1978 program, a similar monitoring program is planned for both environmental houses and commercial layer houses, where the utilization factor is expected to be greater than with the side curtain type house.

Lighting Systems: Demonstration programs for flourescent lighting in poultry houses were extended in this year's program to broiler brooder houses and another broiler growout house, in addition to the broiler growout house used in FY 1976. The results of replacing incandescent lighting with fluorescent lighting have been consistent with predictable energy savings. In addition, the replacement rate of lamps has been greatly reduced. In the case of broilers, the fluorescent light appears to be satisfactory from a standpoint of bird physiology. In one of the installations, an intermittent lighting program is being practiced, with the fluorescent lighting system controlled at fifteen minutes on and two hours off. The results of this program show a drastic reduction in the electric energy needed for lighting and the growing results are good. In the demonstration project involving breeder flock housing, a higher lighting intensity is required than with broilers. After some initial problems with starting of the fluorescent fixtures, the lighting system appears to be performing satisfactorily. It is planned that in the upcoming program, additional information on the physiological effects of different types of lights on poultry will be sought from current research on this subject being performed in California and at Cornell University.

Broiler Processing

The most significant result of the energy conservation research in broiler processing facilities has been the award of a research contract to EES from the U. S. Energy Research and Development Administration for a demonstration program of energy conservation in the U. S. poultry processing industry. This contract award was based on the expertise gained by EES research personnel through the energy conservation work which is sponsored by the Georgia Department of Agriculture. The ERDA sponsored research is also jointly funded by Gold Kist, Inc., who will also provide engineering and technical support and the use of the Gold Kist broiler processing facility in Ellijay, Georgia as the demonstration plant.

Additional work in the broiler processing plants has consisted of evaluation of various energy recovery systems. One of the primary problems which has been experienced with currently marketed energy recovery systems employing heat exchangers has been a fouling problem, due to the contaminated nature of the waste water from the poultry scalder and chiller. In working with engineers representing several firms which market the energy recovery systems, progress has been made in reducing the problem of fouling through more effective pretreatment of the waste water. Heat recovery and energy efficient plant operation have been the primary areas of evaluation and several processing plants are planning projects in these areas. These include the following:

1) Energy recovery at the chiller overflow to recover refrigeration effect from chilled water
2) Insulation of aluminum chillers
3) Metering devices to weigh ice being added to chillers, thus taking credit for ice towards makeup water requirement
4) Heat recovery system at scalder to preheat scalder makeup water or inspectors hand wash water
5) Heat recovery from rendering plant cooking operations for use in adjacent processing plants
6) Heat recovery from ammonia refrigerant at the discharge of the refrigeration compressor to preheat water for scalder makeup and for cleanup
7) Improved boiler and steam system maintenance plan

For the coming year's program in broiler processing, the results of the ERDA sponsored research will be disseminated to all processors in Georgia. However, it is not planned to devote any State funded research efforts to additional work in broiler processing.

<u>Egg Processing</u>

Work with several egg processing plants during this year's program has resulted in identification of a possible heat recovery system which would greatly reduce if not eliminate the need for fuel or electricity to heat hot water. See Figure 6. Since a great deal of paper waste is generated at an egg processing plant which constitutes a waste disposal problem, incinerators are often used to burn the waste. The suggested heat recovery system would

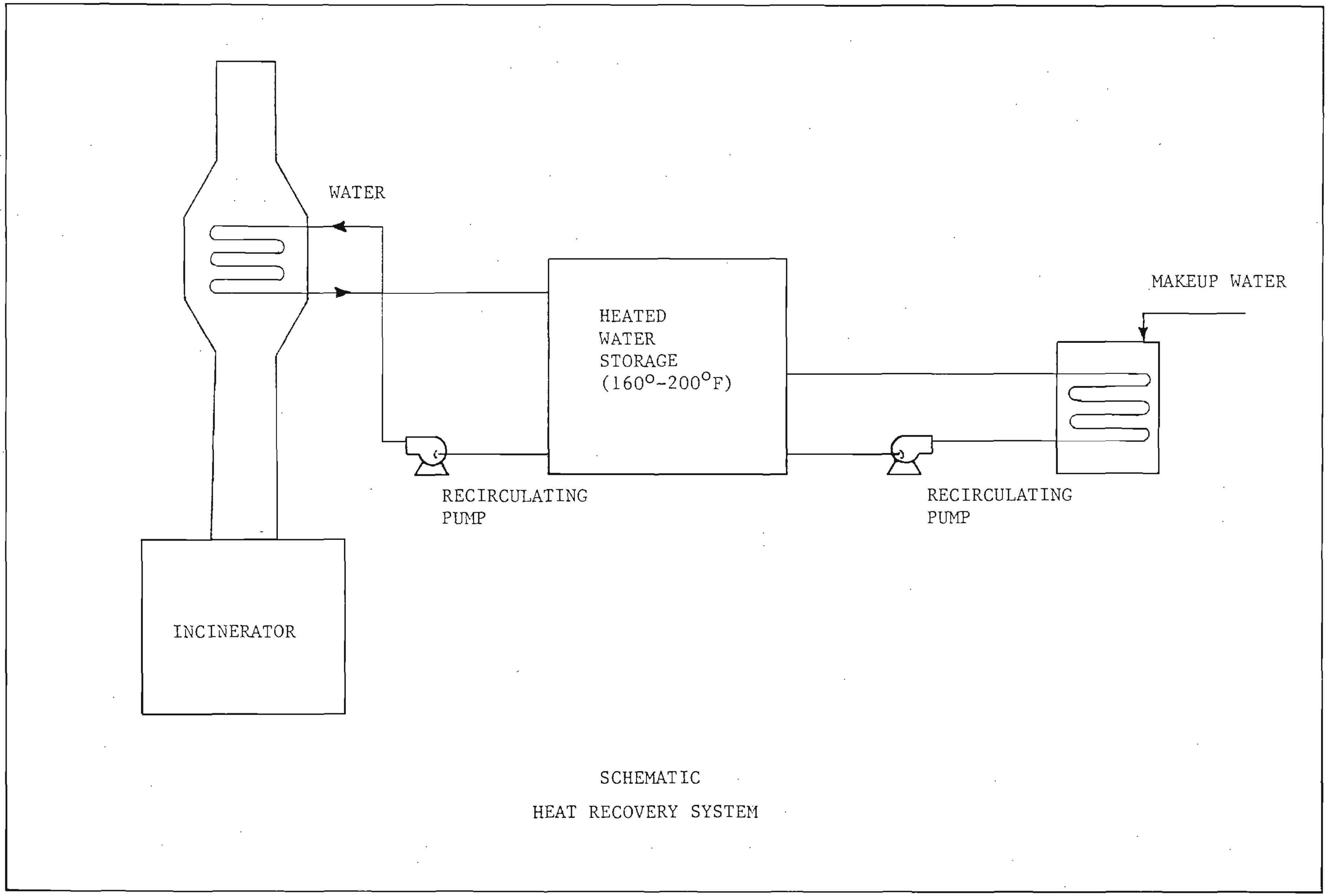


FIGURE 6 Schematic Waste Heat Recovery System

use the hot exhaust gases from the incinerator to heat water or some other heat transfer medium for use in heating water in the egg washers.

Other possible forms of energy conservation in the egg processing plants are electrical demand control systems, heat recovery from the candling operation, and more efficient operation of the egg storage area.

Rendering Operations

A survey of several rendering operations in Georgia has shown that energy costs for these plants amounts to approximately 20% of the production cost as compared to 3.5% for the same figure in a broiler processing plant. The primary energy source in rendering is fossil fuel to fire boilers. In the by-product cooking process, moisture is removed by thermal energy. Removing moisture by mechanical means, such as with a filter press, would require only 1/35th of the energy needed thermally. Therefore, a system for removing moisture mechanically is being evaluated. The disadvantage with this system is the loss of potential product through a mechanical pressing process. However, it is felt that a secondary water treatment system could be utilized to recover grease and solid from the filtrate removed in the press. Dewatering is also a problem with the skimmings from processing plant waste water pre-treatment systems, which may be 98% water. If water content of poultry by-products could be reduced at the processing plant, transportation energy costs as well as rendering energy costs could be reduced significantly.

New process equipment and controls have been evaluated for rendering plants, and it has been determined that continuous drying equipment is available which is much more energy efficient than the traditional batch cookers/dryers. In addition, improved boiler and steam distribution system maintenance has proved to reduce fuel consumption by up to 15%.

Heat recovery potential in a rendering plant is dependent upon the possible uses of the low grade heat. If the rendering plant is located adjacent to a processing plant, a heat recovery system can greatly reduce the amount of steam needed in heating the scalder. However, a rendering plant located apart from other operations only has the opportunity to use the low grade heat recovered from condensing vapors to preheat the offal as it passes to the cookers.

Hatcheries

An engineering analysis of energy consumption in a poultry hatchery indicates that electric energy comprises approximately 60% of the total energy requirement. Since electricity is the most expensive form of energy, conservation efforts in hatcheries have the potential for significant cost savings. One opportunity for energy conservation is recovery of heat from incubator and hatcher exhaust air to use for space heating. Although this heat recovery system has been proven effective in several hatchery operations outside Georgia, few hatcheries within the state have considered such a system, although at least two companies are presently evaluating the concept. Electrical energy is used primarily for environmental control in the hatchery. Initial design of cooling systems in spaces which require both temperature and humidity control can be an important criteria in assuring that excessive energy is not required for humidification. More efficient lighting and increased levels of insulation are additional means of reducing energy needs in the hatchery.

It is evident from the recent survey of energy consumption in the poultry industry that successful measures have been taken to reduce energy from the 1974 levels. However, energy prices in the industry have increased at a rate faster than the reduction in energy consumption. All industry in the U.S. is confronted with a similar situation and it is a situation which will likely worsen. In order to continue to reduce energy consumption as a hedge against rising energy costs, the poultry industry must be willing to invest capital in energy conservation. Demonstration programs have proven to be effective in promoting certain energy conservation measures, and the energy conservation program for the coming year will emphasize results of successfully demonstrated concepts for saving energy as a mechanism for promoting more industry investment.

III. APPLICATION OF SOLAR ENERGY TO BROILER HOUSE HEATING

The severe weather encountered last winter has once again highlighted the necessity of developing an energy source other than fossil fuels to heat broiler houses. The increasing cost of fossil fuels has made solar energy more practical than ever as a replacement energy source. With this in mind, a low-cost passive solar heating system was installed on an operating 20,000 bird capacity broiler house owned by Lamar Hicks. The construction costs of $6,600 were paid by Wilson Foods, Inc. who participated in the program and contracts for Mr. Hicks' broilers. These costs included $3,000 for materials, $2,200 for labor and $1,400 for grading. Figure 7 illustrates the operation of the system.

The collector is located on a south-facing hillside with a 30° slope just below the grow-out house. This location and positioning was selected for ease of access and minimum disruption to normal broiler house operations. The collector is 208' x 16' and consists of a layer of polyethylene lying on the hillside which acts as a vapor barrier, a 6" layer of black-painted rock which acts as an absorber of the solar energy and also provides thermal storage. The rocks are covered with two layers of a 0.006 inch thick Monsanto 602 separated by a dead air space to insulate the rocks. Outside air enters at the bottom of the collector and rises as it gets heated from the solar heated rocks. Natural convection carries it through 8" I.D. concrete pipes into the broiler house.

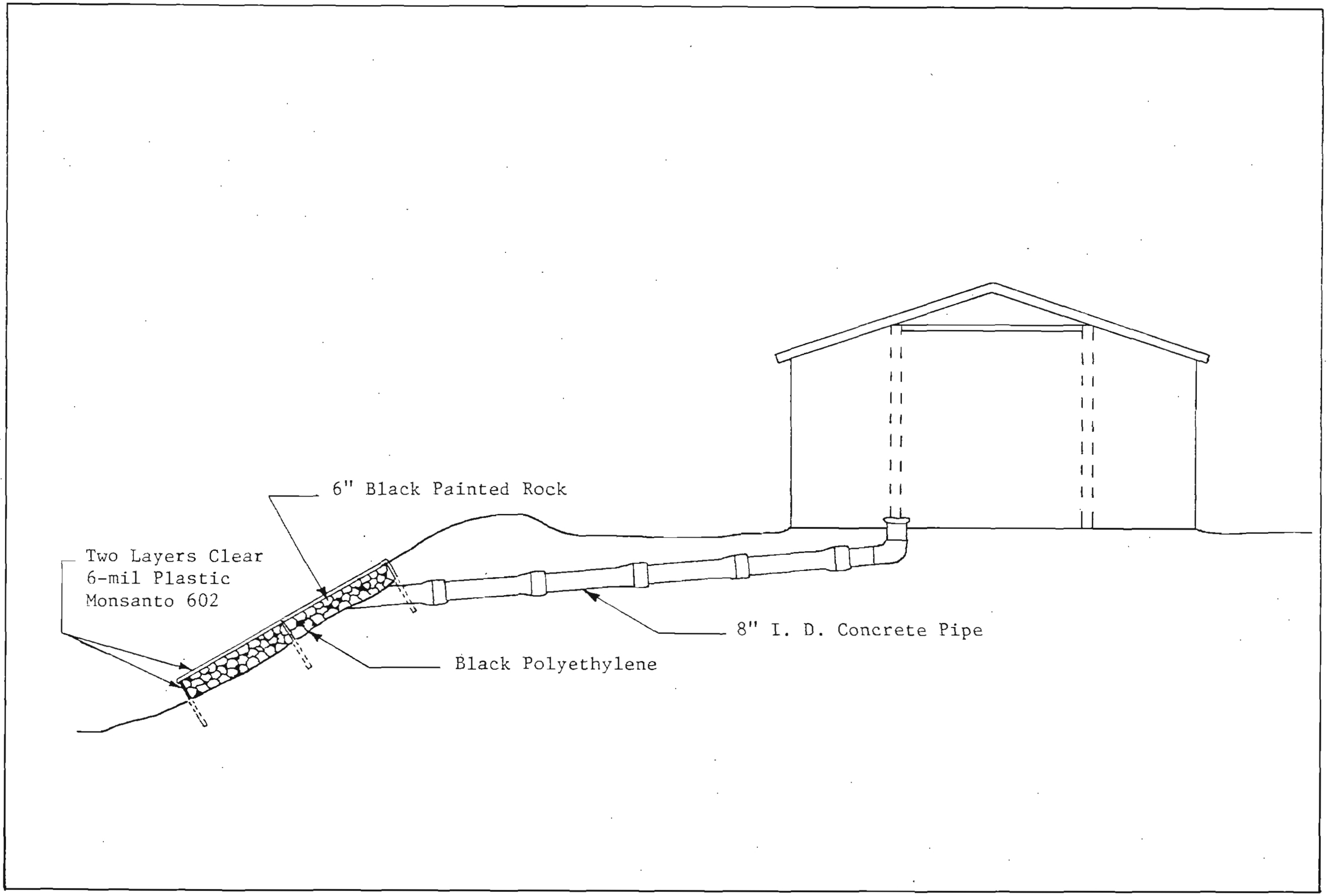


FIGURE 7

Solar Heated Broiler Growout House

Data from poultry research sources indicated that 80% of the heating is required in the first two weeks of brooding. Split house brooding is used in this house and the birds are confined to the center 2/3 of the house during this first two weeks. It was therefore decided to design the collector to provide hot air to the center section of the house. The collector length was determined by the length of this center section, 208 feet. Following a rule of thumb generated by solar energy researchers and used in designing solar heated homes that a collector should be 1/3 to 1/2 the area to be heated, a height of 16 feet was chosen for the collector. Sixteen feet was also chosen because lumber is commonly available in 8 foot lengths and is reasonably easy to handle in 8 foot lengths.

The glazing material which was chosen for the collector is 0.006 in. thick Monsanto 602. This film is often used for greenhouses, is ultra-violet resistant, and is expected to have a useful life of 1 1/2 to 2 years. Glass and fiberglass reinforced plastic materials were considered but were ruled out because of their cost.

A 6 inch black painted layer of rock was chosen as the absorbing surface and to provide thermal storage. Experiments performed on the Tech campus for solar drying of crops have shown that heat does not penetrate a layer of rock more than six inches deep unless air is forced down into the layer of rock. The rocks are Grade B gneiss filter media. They have an average diameter of about 4 inches. This size rock provides a compromise between small rocks with a larger overall surface area and larger rocks, which allow easier air flow through the rocks. This 80 tons of rock should store 1.5 million BTU's at a temperature differential of 50° F.

The 8 inch inner diameter concrete pipes were utilized because they are relatively inexpensive and durable. The outlets from the pipes come out next to existing support beams so as not to interfere with clean-up operations.

A layer of 0.006 in. thick polyethylene was used as an inexpensive vapor barrier between the ground and the collector. This polyethylene was black in order to differentiate it from the Monsanto 602.

Construction of the system began in April 1976 and proceeded as follows:

1. The hill was graded to an angle of approximately 30° and ditches were excavated for the heating ducts.
2. Post holes were dug and treated 4' x 4's were put in the ground. The 4 x 4's were sawed off at six inches above ground level.

3. 8' x 8' frames made out of 2 x 2's were constructed and painted white. The Monsanto was wrapped around the frames and fastened by stapling through a layer of tape. The tape was used to prevent the plastic from tearing at stress points. The workmen neglected to use the tape on some of the frames and we will therefore have an opportunity to observe how this affects the life of the plastic.
4. Black polyethylene was laid on the ground. Cuts were made for the 4 x 4's and the concrete pipe. Roofing cement was used to seal the 4 x 4's and the pipe.
5. 2 x 4's were placed at the bottom of the hill to prevent the rocks from sliding. It appears now that they were unnecessary.
6. The concrete pipe was laid as far as the house. The top of the pipe was broken off as it entered the collector to allow it to fit under the glazing. The pipe was wrapped in polyethylene to keep moisture out.
7. The rocks were delivered to the bottom of the hill and a backhoe was used to place them on the hill.
8. The rocks were spray-painted black.
9. The completed frames were nailed to the 4 x 4 posts. Double headed nails were used to facilitate removal of the frames when the plastic needs to be replaced.
10. Duct tape was used to seal the frames to prevent rain water from entering the collector.
11. Pipe was laid into the house. This step could have occured at step 6, but there were broilers in the house at that time and it was decided to wait until the house was empty. The pipes extend from the floor inside the house next to existing beams so that they do not interfere with cleaning operations.
12. The ground between the collector and the grow-out house was graded to prevent excessive amounts of rain water from being channeled over the collector.

The system was essentially completed on May 10, 1976. It was in service by May 20, 1976. The first full-scale test of the system began on September 27, 1976 with the arrival of a new flock of baby chicks and continued until November 16, 1976 when they were picked up for shipment to the processing plant. During this period the solar heated chicken house used 47% less fuel than the two control, non-solar broiler houses located in the same complex.

The rocks in the collector reached temperatures as high as 180°F with 120 - 160°F being the normal range. The system raised the temperature of the outside air by an average of 18°F. Figure 8 shows the difference between the outside air and the temperature of the air at the collector outlet on a typical sunny day for a 24-hour period during which the outside temperature was as low as 32°F. Even when the collector could not raise the air to the temperature required in the house, the system raised the temperature a portion of the required amount and the auxiliary burners raised the temperature to the desired end value.

The only problem encountered with the system during this test was that the duct tape between the insulating frames became loose because of the high temperatures and ultraviolet radiation. In order to find a tape which could withstand these severe conditions, 8 different tapes were installed on the system and tested. Only one, an aluminized tape held up. It was then ordered for installation on the system.

In order to more closely compare the heating requirements of the solar system with two conventional houses located on the same farm, it was necessary to shut off the solar system for the next flock of broilers. It was found that because the house with the solar system is less well insulated than the other two houses, it requires 10% more heat than they require. Therefore all calculated savings have been adjusted to reflect this difference.

Because of the tests which were being performed on this solar system it was not in use during the entire winter season. However, it is estimated that if a system similar to this were built on an operating farm for $5,600.00 and saved 47% of the heat for a year with the alternative fuel being LP gas then the system would have a 5 year pay back period. The $5,600 cost which is an estimate for reproducing the demonstration unit could be further reduced by the grower constructing the unit himself and it is anticipated that LP and propane gases will continue to increase in price. All of these factors should improve the pay back period for such an investment.

An extended roof hot air collector has also been designed which can be used on a house which does not have an available south facing hillside. It

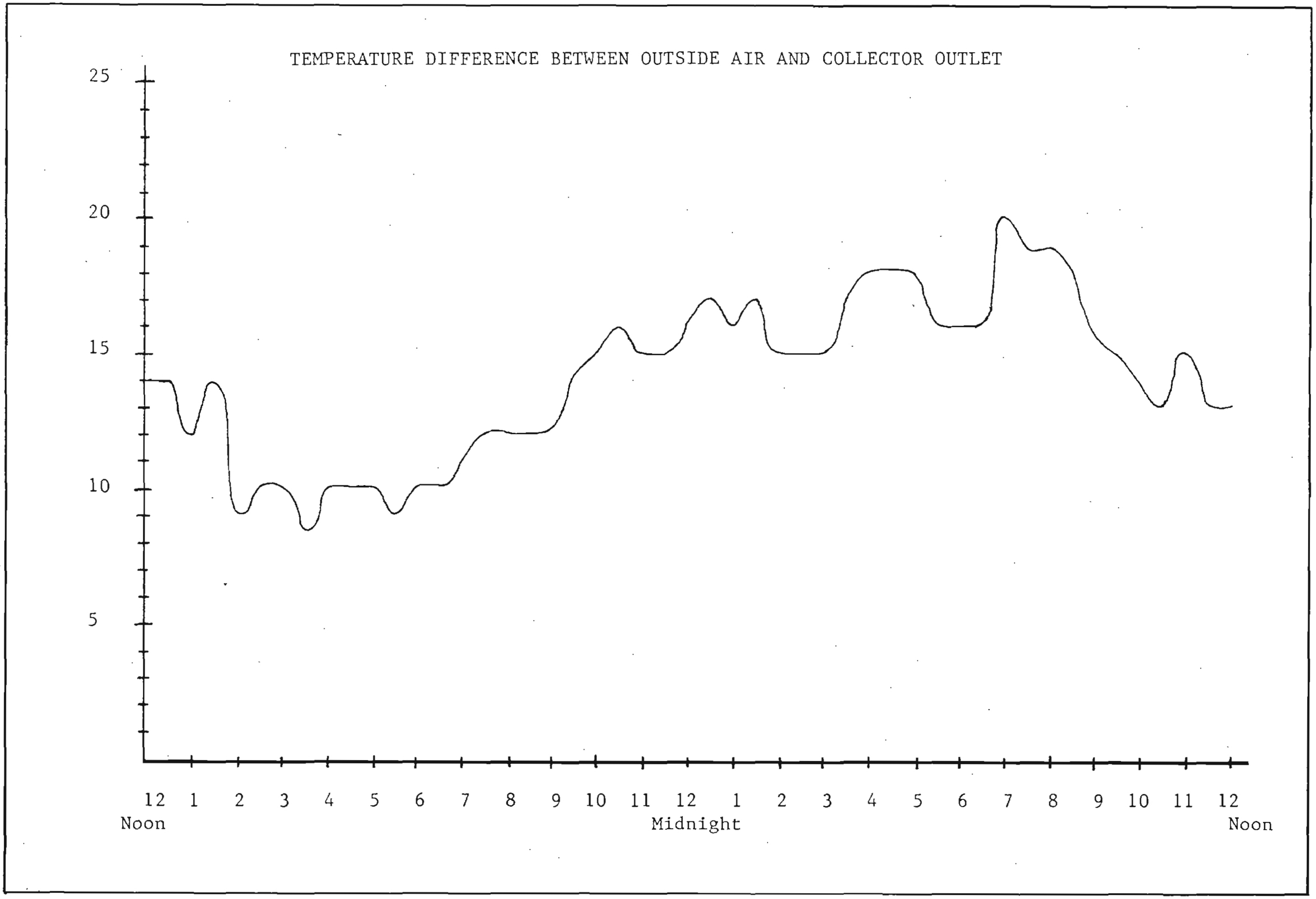

TEMPERATURE DIFFERENCE BETWEEN OUTSIDE AIR AND COLLECTOR OUTLET
25
20
15
10
5
12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
Noon
Midnight
Noon

FIGURE 8

is, however, still required that the house's roof ridge line run east and west. This system is illustrated in Figure 9. Outside air enters the system at the top of the roof-collector and gets heated as it travels down the black painted roof under the layers of plastic glazing and is then pulled through the rock storage bin and into the house.

An attempt will be made to use this system to cool the broiler house in the summer. In this mode of operation outside air will be pulled through the rock storage section of the system at night to cool the rocks. Then during the day, ventillating air for the house will be pulled through the rocks to help cool the house.

It is expected that this system will be in the same price range as the hillside system and a 5,000 ft^2 version of it will produce approximately 70% of the required heat for a 20,000 broiler capacity house. Current plans call for a demonstration unit of this system to be built during the coming year as soon as a farm is chosen.

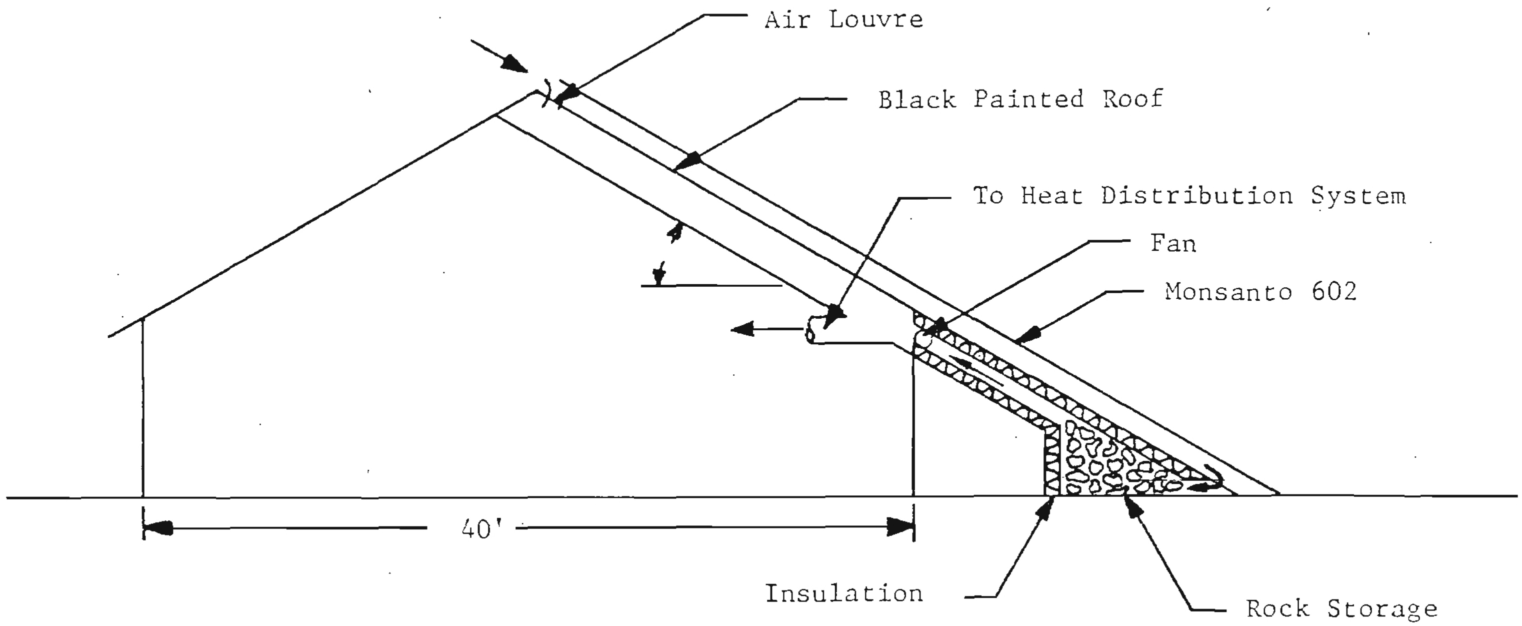


FIGURE 9

EXTENDED ROOF HOT AIR COLLECTOR

IV. MECHANIZATION OF WHOLE BIRD PACKAGING IN POULTRY PROCESSING

This effort was directed to evaluating the procedures currently employed in packaging the finished product in the poultry processing industry in Georgia. A conceptual design, preliminary drawings and an economic analysis of an equipment system designed to increase the level of mechanization within the packing area were to be developed.

The poultry processing industry is an extremely labor intensive operation and could benefit tremendously from almost any new development that would decrease its dependence on low level human labor. Working conditions in a processing plant are not among the most desirable and, as a result, some plants have experienced personnel turnover rates as high as 200-300 percent in one year. This constant influx of new people means that a sizeable percentage of the labor force is just learning the jobs, resulting in a low level of productivity and decreased yield factors. The trend toward reliable, fast operating machinery is a definite advantage to the plant manager whose costs of operations are increasing daily.

The packaging operation was chosen because of its criticality to the processing system and the lack of refinements employed in the operation. A number of equipment manufacturers based in both the United States and abroad serve the processing industry, but the majority of the equipment is designed for the kill and evisceration line where most of the work is done. Mechanization in the packaging area is limited to several designs of weighing scales that classify the processed poultry into various groups based on weight. The packaging area is one of the most labor intensive areas and certain aspects of it would lend themselves well to mechanization. Discussions with representatives of various processing plants throughout the state rated the problem of mechanization as second only to the energy problem facing the industry.

The initial task confronting researchers was to become completely familiar with the procedures and requirements associated with the packaging operation. Visits were made to several poultry processing plants and the variations in procedures were found to be slight. The packaging operation formally begins as the birds are taken out of the chiller and hung on the drip line. In some plants the hangers are responsible for sorting grade A birds from the lower quality grade B birds at this point. Grade B birds generally go to the cut-up department. The purpose of the drip line is to provide a period of time so that the water lodged inside the body cavity of the birds has a chance to drip out. The USDA allows only a 12% water retention, based on weight. The speed of the line may be varied according to the percentage desired. There is always some deviation from the set point in water retention. The shackles upon which the birds are hung are part of the weighing system and can be tripped in such a manner that the bird is released and dropped into the storage bin correnponding to its weight. The processing plants generally pack five different sizes of whole birds: 2 lb., 2 1/4 lb., 2 1/2 lb. to 2 3/4 lb. There are some plants that process spent hens that weigh considerably more.

Once the birds are sized and have fallen into the storage bin, they lie there until a worker packs them into a box. The boxes are filled to either 65 lbs. or 70 lbs. for transportation to the market. A disadvantage of this method is that the first bird into the line is the last one packed. A considerable amount of water is lost by compression in the bin. The body temperature of the birds rises as they lie in the bin. Shelf life and transportability may be adversely affected. A packing station of five weight categories may have three people on the three most common sizes and one other person handling the two less active lines. A full box is placed on the conveyor lines for transport to the weighing station.

At the weighing station the chickens are subjected to their last inspection before shipping. The scale operator adjusts the weight of the box by adding or removing chickens as required and notes the weight on the label that was placed in the box at the packaging station. After been weighed and turning the pertinent label data applied, the box passes on to the icing station where a load of ice for 65 lb. boxes or solid CO_2 for 70 lb. boxes is added to keep the product chilled during transportation to the market. The ice station attendant will add the box top and pass the carton on to the end of the conveyor where it is manually palletized. Depending on scheduling, the boxes are either loaded directly into a truck or into cold storage for later shipping. The number of personnel involved in this operation varies between plants but can be as many as eleven. A schematic representation of the poultry packaging process is given below in Figure 10.

The packaging process consists of ten steps:

1. rehanging birds on drip line at the chiller
2. sorting birds by weight
3. packing birds into the cardboard boxes
4. printing information on the label and applying it to the box
5. transport of box to the weighing station
6. weighing each box and adjusting the weight
7. transport to the icing station
8. adding the box top
9. palletizing the packed boxes
10. transporting boxes to waiting trucks or cold storage

Transportation between operations is almost exclusively by either powered or inclined conveyor belt. An intensive manufacturer search was conducted to attempt to find existing equipment systems which could be modified or adjusted for use in the packaging area. This literature search yielded potential systems in package labeling and box palletizing equipment.

With regard to the type of label used to identify the contents of the packed boxes, it was found that ten separate labels are required. This includes five weight classifications, each with and without giblets. The present label, which has the majority of the information preprinted on it, is the most efficient system of those investigated. The only additional information that is added to the label is the date. There are two choices as to how to attach the label to the box. These are gluing and stapling. A disadvantage of the gluing process is that there is a potential contamination danger. The stapling method was found to be more acceptable and is recommended. This segment of the project was hampered to some degree by the lack of cooperation of the equipment vendors in supplying information concerning the performance of their machines.

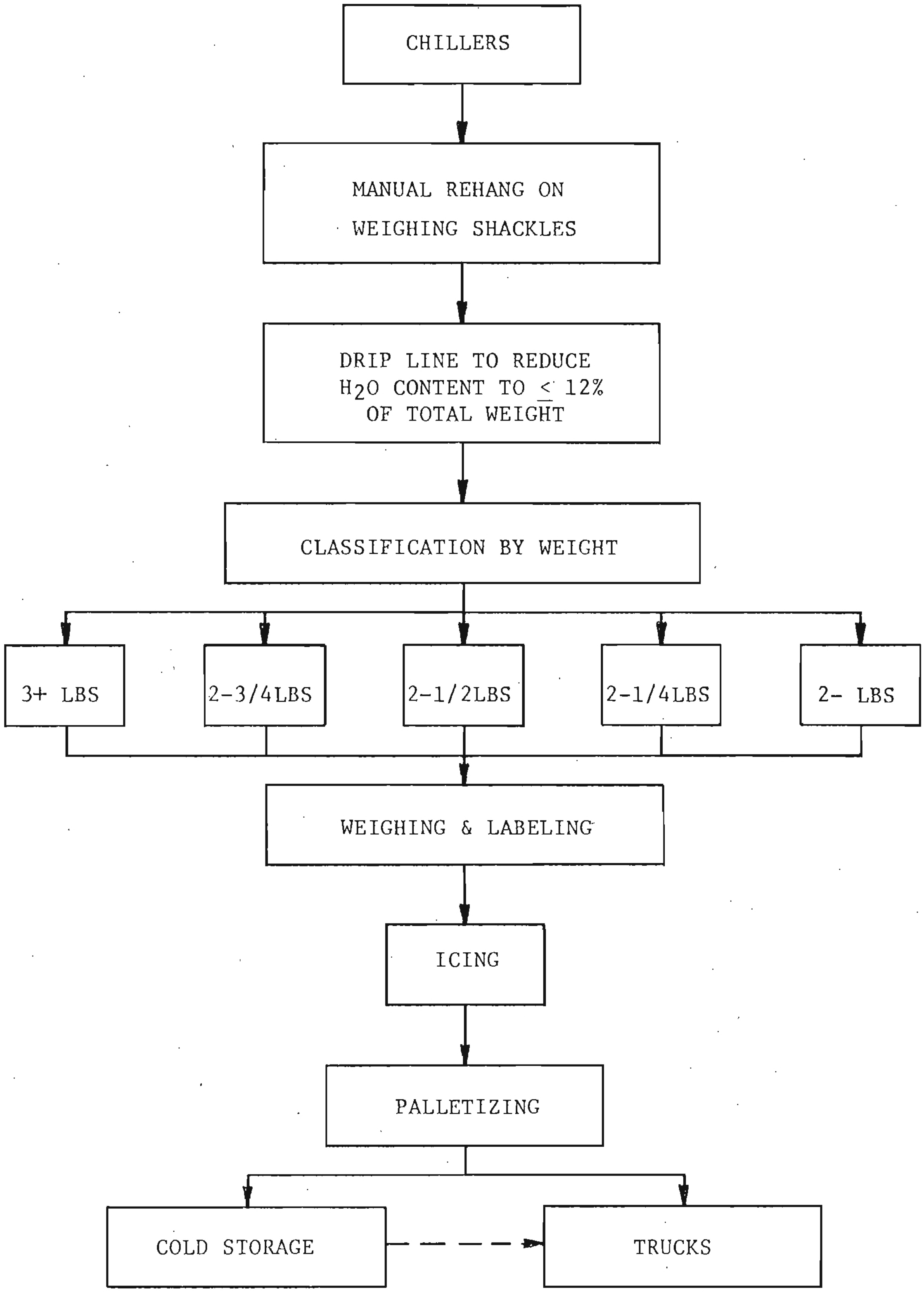


FIGURE 10

PACKAGING PROCESS SCHEMATIC

More information was gathered on the palletizing equipment. This technology is well developed and several models are available to choose from. Two system arrangements were developed for the processing plants which meet the requirement that pallets be loaded with only one size of bird. The two arrangements devised to meet this requirement were, 1) ten separate palletizing machines and 2) a sophisticated material flow and storage system. The first system was dropped because of the extremely high capital cost. Palletizing machines are relatively expensive and to have ten units replacing at most four workers results in a simple payback well over ten years. The second method has a payback in approximately half the time as the former, but the space requirements for the material handling and temporary storage were considered prohibitive. Most poultry processing plants currently have little unused space. Introduction of the second system would impact the plant operations to an unacceptable degree. Therefore the current palletizing system is recommended.

The equipment search yielded a variety of equipment available to provide the same functions that are already being performed adequately by existing systems. The level of sophistication attained by the newer equipment is well above that required by the industry. An exception is the introduction of electronics into the weighing scales. A central control system provides monitoring and totalizing functions for all the packaged birds and generates extremely accurate data on the processing plants production.

The system that indicated the most promise and which was developed more completely because of its potential was the whole bird packaging machine as designed and developed by the W. F. Altenpohl Company of High Point, North Carolina. Altenpohl is already noted in the industry as a manufacturer of chicken weighing system. It was, perhaps, only natural to follow up one step further in the packing area. The machine was designed such that one unit would be required for each weight category. The estimated low capital cost of the system would encourage purchase of the machines. Each machine is smaller than the storage hopper that it will replace. In addition, the machine operates on a "first in, first out" principle so that the time between dropping off the weighing shackle and being packaged is reduced to a minimum. This would have the effect of increasing the shelf life of the product and providing a more uniform weight, requiring less adjusting at the weighing station to achieve the proper weight. The machine would take up less space than the currently employed storage lines. The success of the system lies in the layout of the machines with respect to product flow. The operation of the equipment is so highly automatic that one person could easily tend to four machines without being overburdened.

The mechanization project emphasis was changed from the orginal intent to provide a new concept and designs for increasing the level of mechanization in the packaging area. It was found that with the exception of the packing machines, those systems which are presently in operation are the best available in a practical sense. More expensive and sophisticated equipment exists, but the sophistication is of little value to the processing plant. The whole bird packaging machine was a major step forward in reducing the dependence of the process on low level labor. Installation of a system of the machines packaging the most popular sizes, general 2 1/4 lbs. to 2 1/2 lbs. and 2 3/4 lbs. was found to have a rapid payback because of the replacement of three people with only one person. The thrust of the Engineering Experiment Station work was changed from design of new equipment to assisting in the development and subsequent introduction into the Georgia poultry industry of this whole bird packaging device.

Whole Bird Packaging Machine

The actual packaging of the processed whole birds is a labor intensive operation that lends itself well to automation. The packing process begins as the birds drop off the drip line and fall into storage hoppers according to their weight. A processing plant typically has five or six storage lines. The normal weight distribution of the processed poultry follows the typical bell shaped curve so only two or three of the storage lines are continually worked. The workers load the required number of chickens into each box with a "feet inward" orientation. The boxes are loaded to either 65 or 70 pounds, depending on customer specifications. When loaded, the boxes are placed on a conveyor and passed on to the final inspection and weighing station. A label is prepared and the product is loaded with ice or CO_2, a box top is added and the boxes are palletized.

The whole bird packaging machine was designed and built by the W. F. Altonpohl Company of High Point, North Carolina. The concept was developed in 1976 and in November of that year two prototype units were constructed and installed in the Morgan and Sons processing plant. A third, more refined unit was added in January, 1977. These three machines have been running continously with only a minimum of downtime resulting from failed bearings and other minor mechanical problems. The major components of the units have operated without experiencing any serious defects. The machnies are pneumatically operated and require no electricity. The principle of operation is relatively simple. The packing machine takes the place of the storage hopper into which the sized birds fall. As the birds are tripped off the weighing shackle, they fall into a chute which position the birds in front of a pneumatic ram. The ram is triggered by a bird of the same weight classification still on the drip line just before that bird drops into the machine. The activated ram pushes the initial bird onto a table which, when it is filled with a predetermined number of birds, splits in the middle and drops the properly oriented birds into the box positioned underneath. The box is rotated 180° after each row of chickens is dropped in order to position them with the legs toward the middle.

The whole bird packer's control system is a fluidic system employing compressed air as the controlling medium. Compressed air requirements are approximately five cubic feet per minute at 40 psi. In addition to the fluidic controls, a punched tape strip, which is incremented with each dropping bird, provides the counting function and energizes the various pneumatic cylinders controlling the line rotation and operators signal light. The tape is changed so the machnie can be reprogrammed to pack birds of all sizes by merely changing the tape to allow a greater or lesser number of birds per box depending on weight. Changing the tape requires less than two minutes.

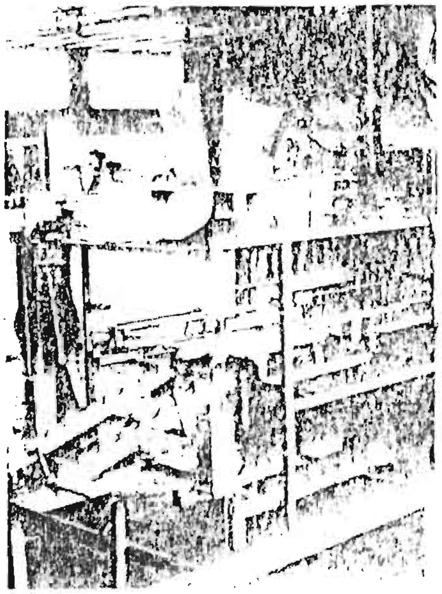
Once the box has been packed, the tape controller activates a ram that advances an empty box and pushes the full box down an incline onto a latch. The heavy box releases the latch, the inclined tracks pivot at the latch trigger, and the box drops past the horizontal down to a track below the empty box. The full box is now transported below the empty box and is routed to a conveyor which takes the box to the wrighing station. Figure 11 depicts the essential elements of the whole bird packing machine and shows some detail of the box transporting system.

The machine is relatively quick and can handle line speeds up to 140 birds per minute without being overloaded. One machine per weighing station is required. With a proper system arrangement it is estimated that one person can easily manage three machines. The work of the human operator would be to ensure that each machine had a steady supply of empty boxes and to move the filled boxes from the lower part of the machine out the conveyor leading to the weighing station. The full potential of the packing machine has not been exploited in the field tests because of severe space limitations. Successful application of the machine will depend on a well designed system layout that will enable the full use of the labor savings features. The machine itself takes up less room than the existing storage lines.

The whole bird packing machine operates on the principle of first in, first out. That is, the first bird dropped off the weighing shackle will be the first one packaged in the box. By comparison, the existing system of storage lines make it impossible for the first bird to be weighed to be first packed because it is at the bottom of a large pile of chickens. The plant's yield factor is adversely affected by this procedure. The birds at the bottom of the hopper are under compression for a period of time and will lose a significant portion of the allowable water content from the body. In addition, the chickens will gain heat from the hopper, which is generally at a higher temperature than the recently chilled birds. This will tend to reduce the shelf life of the birds. Reduction of the time between dropping from the drip line and packaging will allow the birds to retain as much of the moisture in the body as possible, within the prescribed limits. On a daily basis this can translate into a substantial savings. No experimentation has been undertaken to quantify the effect of storage line retention time and water loss, but observations of the amount of water dripping from these lines in a number of processing plants indicates that the savings are potentially significant.

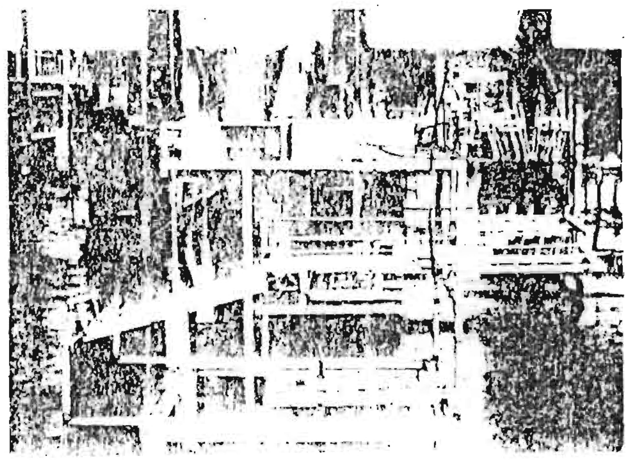
The prototype units have been operating for one and one half machine years without a defect relating to the basic design of the machine. Those failures that have been experienced have been relatively minor and were easily taken care of at the job site. Breakages were normally attributed to undersized pieces of equipment.

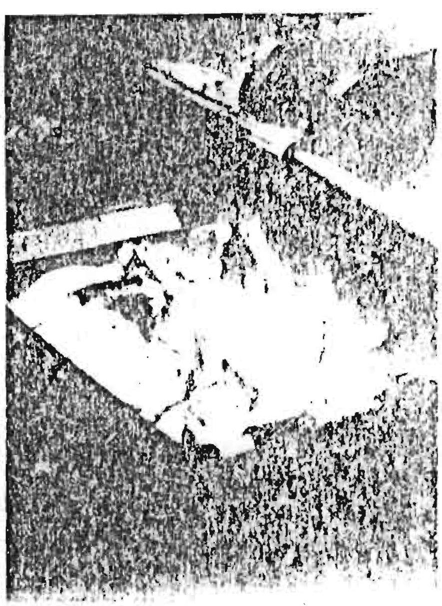
The noise associated with the equipment is relatively high because of the number of air cylinders exhausting to the atmosphere and the table halves slamming together after having dropped a load of birds into the waiting box below. Many of the excessively noisy components will be shielded in the production models. A source of relatively high pressure air must be available to power the unit. The present requirements are 40 psi for the air cylinder



DETAIL OF THE FULL BOX EJECTION SYSTEM SHOWING INCLINED RAMP TO LOWER CONVEYOR

SIDE VIEW OF THE WHOLE BIRD PACKAGING MACHINE SHOWING THE ESSENTIAL COMPONENTS OF THE UNIT.





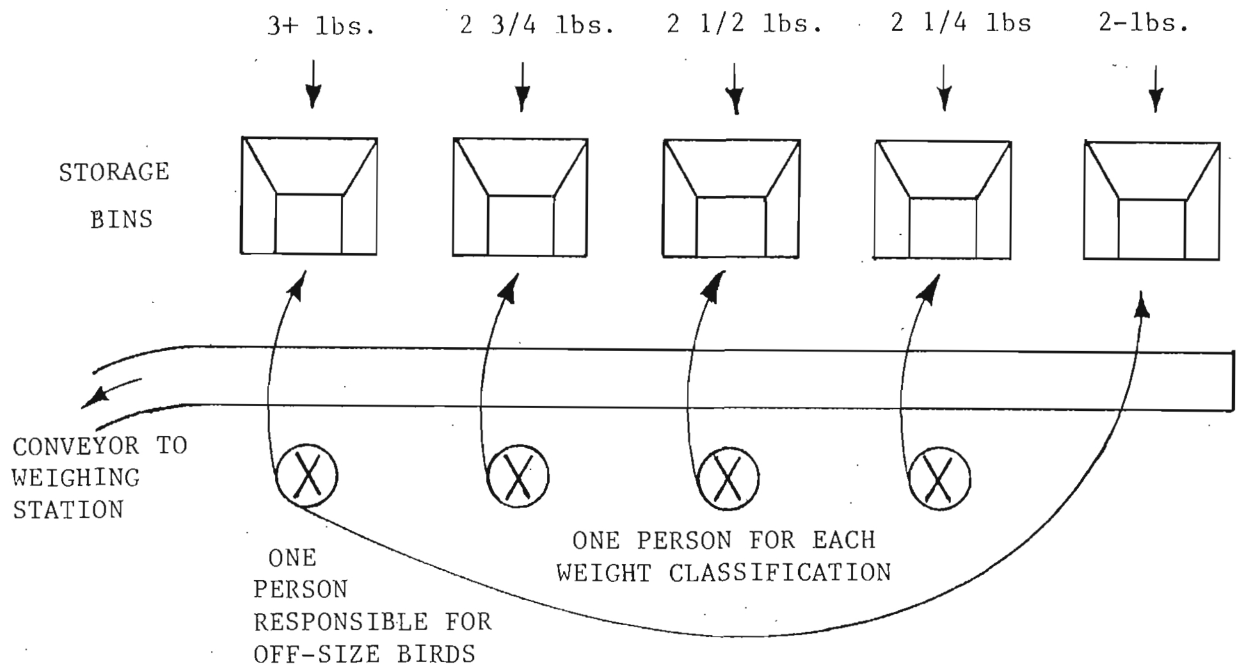
BOX OF PACKAGED PROCESSED BIRDS. LEGS OF THE BIRDS ARE PACKED TO THE INSIDE OF THE BOX. ADDITIONAL BIRDS WERE ADDED TO MEET WEIGHT SPECIFICATIONS.

with a demand of approximately five cubic feet per minute. The cylinders will operate on as low as 25 psi but this is outside the design range and is not recommended. The air demand may necessitate the purchase of another air compressor in order to have reserve capacity in the event of one unit's failure.

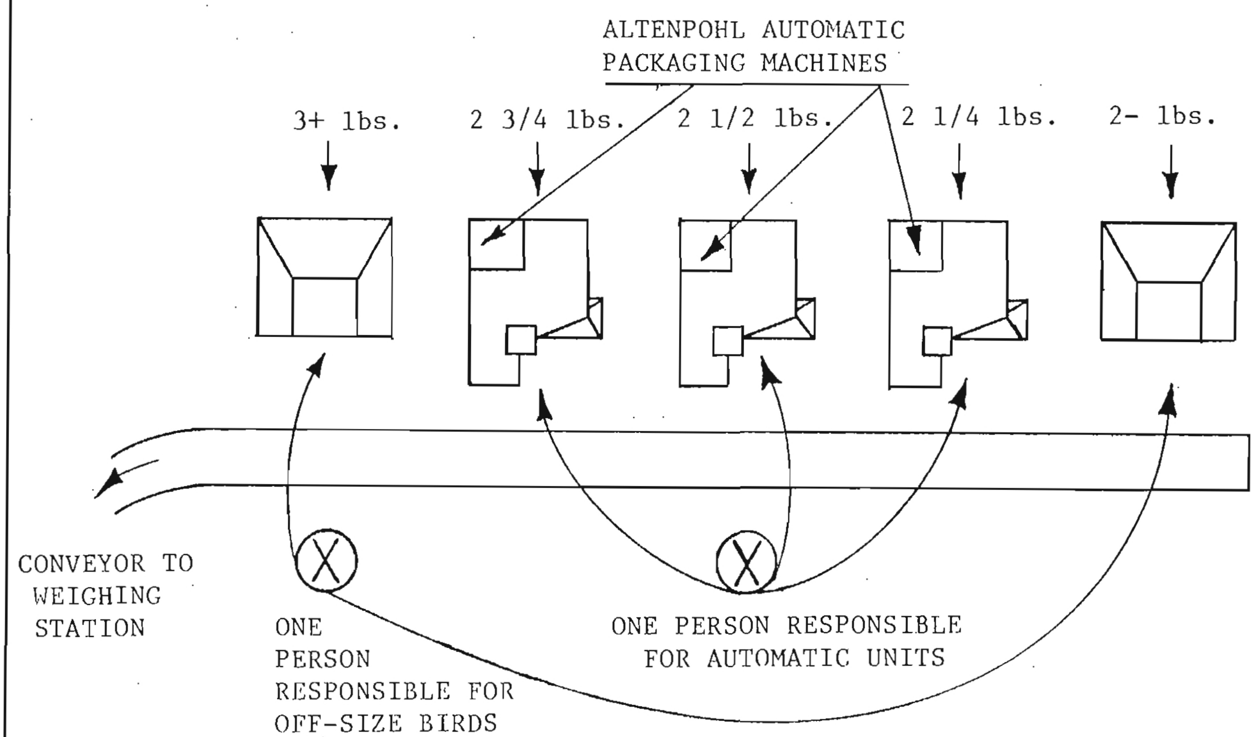
The success of the whole bird packaging system lies in the layout of the machines and the conveyors feeding new boxes and removing the filled ones. Properly laid out, one or at most two people can handle the packing operation. They would merely have to be sure that the machines were supplied with boxes and would have to pull the full boxes out of the machine and onto a conveyor for transport to the weighing station. A poorly designed layout will require the workers to move around too much and limit their effectiveness to the point where an additional person may be required. A layout situation that must be avoided to prevent jamming of the packer is a dual drop off into a single machine. Some processing plants are of large enough capacity to warrant dual evisceration and drip lines. With the installation of a whole bird processing machine this arrangement could result in two birds dropping into the packer simultaneously. The machine would jam and an attendant would have to remove the birds and reset the unit. This complication can be eliminated by introducing a delaying element into one of the drop off chutes. In all likelihood the two lines would not be synchronized such that two would drop at the same time but the possibility must be accounted for.

The poultry processing industry requires a relatively rapid payback on capital equipment. Estimates of how much capital equipment should cost is often developed by using the savings generated by replacing one worker at whatever that person's salary was. As the whole bird packaging machine is not on the market, a firm price has not been established. The manufacturer has indicated that the final price will be in the \$3,000 to \$4,000 range.

As an example of how rapidly an automatic bird packaging system can return its initial investment, consider the following system. Figure 12 shows the existing and proposed systems. Five different weight categories are packed and four people are employed to manually pack the boxes. Three people are used on the three most common sizes and a fourth person handles the two relatively inactive sizes. Assuming a salary of \$9,000 for each employee, the annual amount spent on labor is \$36,000. Installing the whole bird packing machine at the three most active stations would reduce the personnel requirements to only two: one for the three machines and one to



EXISTING SYSTEM EMPLOYING FOUR PACKERS, ONE OF WHOM COVERS THE SLACK SIZES



A POTENTIAL PACKING SYSTEM UTILIZING ALTENPOHL
AUTOMATIC WHOLE BIRD PACKING MACHINES

Comparison of Existing and Proposed Packaging Facilities